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# DARLINGTON NGS 'A'
# EMERGENCY POWER GENERATOR #1
# VIBRATION ACCEPTANCE TESTS

Report No 90-338-K

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## ABSTRACT

As part of the Darlington NGS commissioning program, acceptance tests were carried out on Emergency Power Generator #1 to determine its vibration and dynamic characteristics. Casing velocity levels and/or shaft displacement levels were obtained on the AC generator, reduction gearbox, power turbine, gas producer and accessory gearbox at various loads. Vibration levels were also obtained during runup and rundown of the unit and were used to determine rotor critical speeds. Impact tests were performed to determine structural natural frequencies.

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## EXECUTIVE SUMMARY

## DARLINGTON NGS 'A' EMERGENCY POWER GENERATOR #1 VIBRATION ACCEPTANCE TESTS

N. Jagan and P. Hoogendam

As part of the Darlington NGS commissioning program, acceptance tests were carried out on Emergency Power Generator #1 to determine its vibration and dynamic characteristics.

The overall shaft displacement and bearing casing velocity levels measured on the AC generator, at various loads ranging from 0 MW to 6.9 MW, are considered acceptable. The overall velocity levels measured on the power turbine casing close to Bearing No 5 are unacceptable. The overall shaft displacement levels measured at the power turbine and producer bearings are considered acceptable at all loads tested.

Structural dynamics testing indicates that the AC generator has structural natural frequencies at approximately 28.5 Hz and 32 Hz which are close to its synchronous speed (30 Hz). A rotor critical speed of the AC generator was identified at 1740 rpm (29 Hz) which is within 3% of the synchronous speed. The generator response at this critical speed, however, appears to be relatively well damped and thus the critical speed is not likely to be a problem. Rotor critical speeds of the power turbine were identified at approximately 2810 rpm (47 Hz) and 3770 rpm (63 Hz). No other rotor critical speeds were identified below the power turbine overspeed of 9290 rpm. Rotor critical speeds of the gas producer were identified at approximately 2660 rpm (44 Hz), 3025 rpm (50 Hz), 3900 rpm (65 Hz), 5000 rpm (83 Hz) and 5290 rpm (88 Hz). No other rotor critical speeds were identified below the gas producer speed of 11000 rpm.

It is recommended that velocity spectra be periodically obtained on the AC generator bearing casings to trend the 30 Hz component. Displacement transducers should be installed at the AC generator bearings so that shaft displacements levels can be monitored. The manufacturer, Darlington Operations and Engineering, and Mechanical Research should discuss the feasibility of detuning the structural natural frequencies of the AC generator close to its synchronous speed. The manufacturer should address the acceptability of the rotor critical speed of the AC generator within 3% of its synchronous speed. The high vibration levels measured on the power turbine casing close to Bearing No 5 should be reduced.

| job | file | date | report no. |
|---|---|---|---|
| 740627-179-552 | 825.4 | February 1, 1991 | 90-338-K |

## TABLE OF CONTENTS

Page No

1.0 INTRODUCTION 1

2.0 TEST PROGRAM, INSTRUMENTATION AND MEASUREMENTS 2

3.0 ALARM AND SHUTDOWN VIBRATION LIMITS 3

4.0 RESULTS AND DISCUSSION 3

4.1 Casing Overall Velocity Levels and Velocity Spectra 3

4.1.1 AC Generator Casing Vibration 3
4.1.2 Reduction Gearbox Casing Vibration 4
4.1.3 Power Turbine Casing Vibration 5
4.1.4 Accessory Gearbox Casing Vibration 5

4.2 Shaft Overall Displacement Levels and Displacement Spectra 5

4.2.1 AC Generator Shaft Vibration 6
4.2.2 Power Turbine Shaft Vibration 6
4.2.3 Gas Producer Shaft Vibration 7

4.3 Cold Start Runup Bode Plots 7

4.4 Hot Rundown Bode Plots 8

4.5 Rotor Natural Frequencies 8

4.6 Structural Natural Frequencies 9

4.6.1 AC Generator Structural Natural Frequencies 9
4.6.2 Reduction Gearbox Structural Natural Frequencies 10
4.6.3 Power Turbine Structural Natural Frequencies 10
4.6.4 Gas Producer Structural Natural Frequencies 10

5.0 CONCLUSIONS 10

6.0 RECOMMENDATIONS 11

ACKNOWLEDGMENTS 12

REFERENCES

TABLES 14

FIGURES 24

APPENDIX A: Description of Turbine-Generator Set 29

APPENDIX B: AC Generator Velocity and Displacement Spectra 37

Page No

APPENDIX C: Reduction Gearbox Velocity Spectra 111

APPENDIX D: Power Turbine Velocity and Displacement Spectra 137

APPENDIX E: Accessory Gearbox Velocity Spectra 195

APPENDIX F: Gas Producer Displacement Spectra 205

APPENDIX G: Bode Plots of Vibration During Cold Start Runup 255

APPENDIX H: Bode Plots of Vibration During Hot Rundown 278

APPENDIX I: Impact Spectra 301

APPENDIX J: Instrumentation and Measurements 317

DISTRIBUTION

## LIST OF TABLES

TABLE 1 : Instrumentation List

TABLE 2 : Darlington NGS 'A' Emergency Power Generator #1 - AC Generator 1 x Synchronous (30 Hz), 2 x Synchronous and Overall Casing Velocity Levels

TABLE 3 : Darlington NGS 'A' Emergency Power Generator #1 - AC Generator 1 x Synchronous (30 Hz), 2 x Synchronous and Overall Casing Velocity Levels

TABLE 4 : Darlington NGS 'A' Emergency Power Generator #1 - Reduction Gearbox (RGB) Casing Velocity Levels

TABLE 5 : Darlington NGS 'A' Emergency Power Generator #1 - Power Turbine Bearing No 5 Casing Velocity Levels

TABLE 6 : Darlington NGS 'A' Emergency Power Generator #1 - Accessory Gearbox (AGB) Casing Velocity Levels

TABLE 7 : Darlington NGS 'A' Emergency Power Generator #1 - AC Generator 1 x Synchronous (30 Hz), 2 x Synchronous and Overall Shaft Displacement Levels

TABLE 8 : Darlington NGS 'A' Emergency Power Generator #1 - Power Turbine 1 x Synchronous (143 Hz), 30 Hz Component and Overall Shaft Displacement Levels

TABLE 9 : Darlington NGS 'A' Emergency Power Generator #1 - Gas Producer 1 x Synchronous, 2 x Synchronous and Overall Shaft Displacement Levels

TABLE 10 : Darlington NGS 'A' Emergency Power Generator #1 - Gas Producer 1 x Synchronous, 2 x Synchronous and Overall Shaft Displacement Levels

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To Mr. D. McQuade
Technical Manager
Darlington NGS 'A'

# DARLINGTON NGS 'A' EMERGENCY POWER GENERATOR #1
# VIBRATION ACCEPTANCE TESTS

## 1.0 INTRODUCTION

Vibration acceptance tests were carried out on the two emergency power generators EPG #1 and EPG #2, each rated at 6.8 MW, as part of the Darlington NGS 'A' commissioning program. This report discusses the results of the tests on EPG #1. Vibration data for EPG #2 can be found in reference 1.

The principal objectives of the tests were to:

1) Evaluate the acceptability of the machine vibration and dynamic characteristics with respect to specifications and/or industry standards.

2) Obtain baseline vibration data for use in future machine monitoring.

3) Make recommendations for corrective actions if required.

The general turbine-generator arrangement is shown in Figures 1 and 2. The main components of the turbine-driven generator set (Solar Turbines) are the Mars industrial turbine engine, the Allen Gear speed-reducing epicyclical gear unit (4.76 gear ratio), and the Brush AC generator. The main components of the gas turbine engine are the compressor, the 2-stage gas producer and the 2-stage power turbine. A further description of the turbine-generator set is given in Appendix A.

Based on the results of some initial vibration tests on EPG #1, the original reduction gearbox was rejected due to high subsynchronous vibration and internal housing skew misalignment /2/. A replacement gearbox of a new design was installed. The vibration data presented in this report are for EPG #1 with the new gearbox installed.

The AC generator synchronous speed is 1800 rpm (30 Hz) and the power turbine synchronous speed is 8568 rpm (142.8 Hz). The speed of the gas producer varied from approximately 8906 rpm (148.4 Hz) to 10270 rpm (171.2 Hz) depending on load.

## 2.0 TEST PROGRAM, INSTRUMENTATION AND MEASUREMENTS

The test procedure for EPG #1 is outlined below :

1. The cold soaked unit was started, synchronized and the load raised to full load for the ambient temperature, at the maximum allowable rate. The unit was held at full load for approximately one hour. All vibration signals were recorded on magnetic tape during runup and full load operating conditions.

2. The load was reduced at the maximum rate and the unit was shutdown.

3. The unit was restarted overnight and left to run for a minimum of 6 hours to allow for hot alignment of the unit.

4. In order to evaluate the unit's vibration characteristics under different loads, the unit's power was decreased from the maximum load attainable (6.9 MW) to approximately 0 MW (synchronous idle). Loads of 6.9 MW, 6 MW, 5 MW, 4 MW, 3 MW, 2MW, 1 MW and 0 MW were selected. At each load, the unit was allowed to stabilize for approximately 20 minutes before the vibration signals were recorded.

5. From synchronous idle, the speed was raised to approximately 8 percent above the synchronous speed. The unit was allowed to trip and rundown.

6. The unit was restarted within ten minutes of fuel shutoff (hot start), synchronized and the load raised to full load at the maximum attainable rate.

7. The unit was held at full load for approximately 30 minutes. The load was then reduced to zero and the speed raised to approximately 8 % over the synchronous speed. The unit was tripped and allowed to run down.

8. Structural dynamics testing was carried out with the unit not running.

Vibration data was recorded on tape during periods of runup and rundown, and at each load setting.

Overall vibration velocity levels and spectra were obtained on the AC generator inboard and outboard bearing casings, on the reduction and accessory gear box casings, and on the power turbine casing (close to Bearing No 5). Velocity measurements were generally obtained in the vertical, horizontal, and axial directions. Overall shaft displacement levels and spectra were obtained at the bearing locations shown in Figure 1. Displacement measurements were taken in both the horizontal and vertical directions.

During runup and rundown of the unit, velocity and shaft displacement magnitude and phase at filtered 1 x shaft rotating frequency, versus shaft speed were plotted (Bode plot).

The test instrumentation (Table 1) and measurements are presented in Appendix J.

## 3.0 ALARM AND SHUTDOWN VIBRATION LIMITS

The alarm and shutdown limits (based on overall levels) specified for the emergency power generator /3/ are as follows.

| | Alarm | Shutdown |
|---|---|---|
| AC Generator Bearing Casing Velocity (mm/s) | 5.1 | 6.4 |
| Reduction Gear Box Casing Velocity (mm/s) | 9.0 | 12.0 |
| Accessory Gear Box Casing Velocity (mm/s) | 13.0 | 20.0 |
| Power Turbine Shaft Displacement (μm p-p) (Bearings No 4 and No 5) | 64.0 | 100.0 |
| Gas Producer Shaft Displacement (μm p-p | | |
| - Bearing No 1 | 64 | 100.0 |
| - Bearing No 2 | 64 | 89.0 |
| - Bearing No 3 | 64 | 100.0 |

## 4.0 RESULTS AND DISCUSSION

Provided in this section are the casing and shaft vibration levels measured on the various components of the power generator. Bode plots obtained during runup and rundown are presented. Structural and rotor natural frequencies, identified from impact spectra and bode plots, are also presented.

### 4.1 Casing Overall Velocity Levels and Velocity Spectra

The casing velocity measurements obtained during the tests are presented below in the following sections :

| | |
|---|---|
| Section 4.1.1 | AC Generator Casing Vibration |
| Section 4.1.2 | Reduction Gearbox Casing Vibration |
| Section 4.1.3 | Power Turbine Casing Vibration |
| Section 4.1.4 | Accessory Gearbox Casing Vibration |

#### 4.1.1 AC Generator Casing Vibration

The overall velocity levels measured at the AC generator bearing casings at the various loads are shown in Tables 2 and 3. The maximum overall velocity levels (horizontal and vertical directions) are:

|  | Maximum Overall Velocity (mm/s) |  | Percent of Alarm Level |
|---|---|---|---|
|  | RMS Level | Peak Level |  |
| Outboard Bearing Casing | 2.0 | 3.7 | 73 |
| Inboard Bearing Casing | 1.5 | 3.6 | 71 |

These levels are acceptable. According to the Darlington NGS tendering document, for acceptance purposes the maximum lateral vibration measured on the bearing housings should not exceed 2.8 mm/s RMS.

Velocity spectra obtained at the AC generator bearing casing for the various loads are shown in Appendix B, Figures B1 - B40. These spectra show that the main frequency component is generally at 1 x synchronous frequency. The vibration amplitudes at 1 x and 2 x synchronous frequency are shown in Tables 2 and 3.

At the 1 MW load a subsynchronous vibration component at approximately 25.5 Hz is present in the velocity spectra obtained on the generator casing. At the other loads tested (2 MW to 6.9 MW) this subsynchronous component is not present. The maximum amplitude of the subsynchronous component was 0.8 mm/s measured on the inboard bearing casing in the horizontal direction (Appendix B, Figure B26). The subsynchronous vibration, also present on EPG2, was discussed in some detail in reference 1.

### 4.1.2 Reduction Gearbox Casing Vibration

The overall velocity levels measured on the reduction gearbox (RGB) casing at various loads are summarized in Table 4. The maximum overall velocities are :

|  | Maximum Overall Velocity (mm/s) |  | Percent of Alarm Level |
|---|---|---|---|
|  | RMS Level | Peak Level |  |
| RGB Casing | 2.3 | 6.4 | 71 |

These levels are considered to be acceptable given that the EPG operates for relatively short durations.

Velocity spectra obtained on the RGB casing at the various loads are shown in Appendix C, Figures C1 - C24.

### 4.1.3 Power Turbine Casing Vibration

The overall velocity levels measured on the power turbine (PT) casing close to Bearing No 5 (Figure 2) at the various loads are shown in Table 5. The maximum overall velocity levels are :

| | Maximum Overall Velocity (mm/s) | |
|---|---|---|
| | RMS Level | Peak Level |
| Power Turbine Casing | 8.0 | 17.9 |

These levels are considered unacceptable for turbomachinery bearing housing vibration and should be reduced.

Velocity spectra obtained on the power turbine bearing casing are shown in Appendix D, Figures D1 - D24. The spectra show that the main vibration components in the horizontal and vertical directions are at 143 Hz (power turbine synchronous speed), at 30 Hz (AC generator synchronous speed) and at 60 Hz (2 x AC generator synchronous speed). The velocity levels at 30 Hz and 143 Hz are given in Table 5.

Impact spectra obtained at this location show a structural natural frequency at 29.5 Hz (Appendix I, Figure I12). This natural frequency would amplify the power turbine casing response at 30 Hz.

### 4.1.4 Accessory Gearbox Casing Vibration

The overall velocity levels measured on the accessory gearbox (AGB) casing in the horizontal direction at various loads are summarized in Table 6. The maximum overall velocity levels are :

| | Maximum Overall Velocity (mm/s) | | Percent of Alarm Level |
|---|---|---|---|
| | RMS Level | Peak Level | |
| RGB Casing | 1.2 | 3.8 | 29 |

These levels are acceptable.

Velocity spectra obtained on the AGB casing at the various loads are shown in Appendix E, Figures E1 - E8.

## 4.2 Shaft Overall Displacement Levels and Displacement Spectra

The shaft displacement measurements obtained during the tests are presented below in the following sections :

| | |
|---|---|
| Section 4.2.1 | AC Generator Shaft Vibration |
| Section 4.2.2 | Power Turbine Shaft Vibration |
| Section 4.2.3 | Gas Producer Shaft Vibration |

### 4.2.1 AC Generator Shaft Vibration

Overall shaft displacement levels measured at the inboard and outboard bearings of the AC generator at various loads are shown in Table 7. The maximum overall shaft displacement levels are:

| | Maximum Overall Displacement (μm p-p) |
|---|---|
| Outboard Bearing | 35 |
| Inboard Bearing | 38 |

These levels are acceptable. According to the Darlington NGS tendering document, for acceptance purposes the maximum shaft vibration should not exceed 60 μm p-p during operation.

Shaft displacement spectra obtained on the AC generator for the various loads are shown in Appendix B, Figures B41 - B72. These spectra show that the main vibration components are generally at the 1 x synchronous (30 Hz) and 2 x synchronous (60 Hz) frequencies. The displacement levels at these frequencies are shown in Table 7.

At a load of 1 MW, the subsynchronous vibration at approximately 25.5 Hz was present in the shaft vibration and had a maximum amplitude of 21 μm p-p (Appendix B, Figure B66).

### 4.2.2 Power Turbine Shaft Vibration

Overall shaft displacement levels measured at Bearings No 4 and No 5 of the power turbine (PT) are presented in Table 8. The maximum overall shaft displacement levels are:

| | Maximum Overall Displacement (μm p-p) | Percent of Alarm Level |
|---|---|---|
| Bearing No 4 | 11 | 17 |
| Bearing No 5 | 20 | 31 |

These levels are acceptable.

Shaft displacement spectra obtained on the power turbine for the various loads are shown in Appendix D, Figures D25 - D56. These spectra show that the main vibration components are generally at the power turbine synchronous frequency (143 Hz) and at 30 Hz. The displacement levels at these frequencies are listed in Table 8. The sub-AC generator synchronous vibration, present at a load of 1 MW, did not exceed 2 μm p-p at either bearing.

### 4.2.3 Gas Producer Shaft Vibration

Overall shaft displacement levels measured at Bearings No 1, No 2 and No 3 of the gas producer (GP) are presented in Tables 9 and 10. The maximum overall shaft displacement levels are:

| | Maximum Overall Displacement (μm p-p) | Percent of Alarm Level |
|---|---|---|
| Bearing No 1 | 11 | 17 |
| Bearing No 2 | 34 | 53 |
| Bearing No 3 | 22 | 34 |

These levels are acceptable.

Shaft displacement spectra obtained on the gas producer for the various loads are shown in Appendix F, Figures F1 - F48. These spectra show that the main vibration component is generally at the gas producer synchronous frequency. The gas producer synchronous speed varied with load from approximately 8906 rpm (148.4 Hz) at no load to approximately 10270 rpm (171.2 Hz) at full load. The displacement levels at 1 x and 2 x GP synchronous frequency are listed in Tables 9 and 10.

There was no significant shaft vibration at the sub-AC generator synchronous frequency at any of the gas producer's bearings.

### 4.3 Cold Start Runup Bode Plots

1 x RPM filtered bode plots of the AC generator and power turbine casing velocity and shaft displacement levels obtained during the cold start runup are presented in Appendix G. Bode plots of the gas producer shaft displacement levels are also shown. Compensated and uncompensated bode plots are shown for the shaft displacement signals.

The maximum overall shaft displacement levels measured during the cold start runup are:

| | Maximum Overall Displacement (μm p-p) |
|---|---|
| AC Generator Outboard Bearing | 37 |
| AC Generator Inboard Bearing | 33 |
| Gas Producer Bearing No 1 | 17 |
| Gas Producer Bearing No 2 | 26 |
| Gas Producer Bearing No 3 | 12 |
| Power Turbine Bearing No 4 | 15 |
| Power Turbine Bearing No 5 | 20 |

## 4.4 Hot Rundown Bode Plots

1 x RPM filtered bode plots of the AC generator and power turbine casing velocity and shaft displacement levels obtained during the hot rundown are presented in Appendix H. Bode plots of the gas producer shaft displacement levels are also shown.

The maximum overall and filtered (1 x RPM) shaft displacement levels measured during the hot rundown are:

| | Maximum Displacement (μm p-p) | |
|---|---|---|
| | Overall | 1 x Filtered |
| AC Generator Outboard Bearing | 35 | 16 |
| AC Generator Inboard Bearing | 28 | 20 |
| Gas Producer Bearing No 1 | 14 | 10 |
| Gas Producer Bearing No 2 | 30 | 28 |
| Gas Producer Bearing No 3 | 14 | 19 |
| Power Turbine Bearing No 4 | 19 | 4 |
| Power Turbine Bearing No 5 | 28 | 10 |

## 4.5 Rotor Natural Frequencies

The bode plots obtained during runup and rundown were used to identify the rotor natural frequencies (critical speeds) of the AC generator, power turbine and gas producer.

The critical speeds of the AC generator, power turbine and gas producer that were identified from bode plots are :

| | | Critical Speeds | Percent of Synchronous Speed |
|---|---|---|---|
| AC Generator | - | 1740 rpm (29 Hz) | 97 |
| Power Turbine | - | 2810 rpm (47 Hz) | 32 |
| | - | 3770 rpm (63 Hz) | 44 |
| Gas Producer* | - | 2660 rpm (44 Hz) | 30 |
| | - | 3025 rpm (50 Hz) | 34 |
| | - | 3900 rpm (65 Hz) | 44 |
| | - | 5000 rpm (83 Hz) | 56 |
| | - | 5290 rpm (88 Hz) | 59 |

* Percent of GP Synchronous speed based on minimum speed measured of 8906 rpm.

The rotor natural frequency of the AC generator at approximately 1740 rpm (29 Hz) is within 3 % of the AC generator synchronous speed (1800 rpm). The typical standard in industry prohibits critical speeds to be located between 15 percent below the minimum speed to 20 percent above the maximum continuous speed. The AC generator critical speed at 1740 rpm does not meet this requirement. However, the generator response at the critical speed appears to be relatively well damped and thus the critical speed is not likely to be a problem. The measured AC generator shaft vibration (Table 7) is also acceptable. Nevertheless, it is recommended that displacement transducers be installed at the AC generator bearings so that the shaft displacement levels can be periodically monitored.

Besides those rotor natural frequencies listed in the above table, no other rotor critical speeds of the AC generator, power turbine or gas producer could be identified below their maximum attainable overspeeds (for the test) of 1950 rpm, 9290 rpm, and 11000 rpm respectively.

## 4.6 Structural Natural Frequencies

### 4.6.1 AC Generator Structural Natural Frequencies

Impact spectra (compliance transfer functions) obtained on the AC generator casing and exciter are shown in Figures I1 to I7 (Appendix I).

Impact spectra obtained on the AC generator casing in the horizontal direction (Figures I4 and I6) show a structural natural frequency at approximately 32 Hz. This structural natural frequency is very close to the synchronous speed (30 Hz) and will amplify the casing vibration. However, the filtered (1 x synchronous speed) velocity levels measured on the AC generator bearing casings (Tables 2 and 3) in the horizontal direction are considered acceptable. Nevertheless, the vibration amplitude at the 30 Hz is dependent on the level of excitation at this frequency. Should this excitation increase in the future (possibly due to increased unbalance), amplification of the casing response by the structural natural frequency may result in unacceptable levels of vibration. In view of this, it is recommended that velocity spectra be periodically measured at the AC generator bearing casings in the horizontal direction to obtain a trend of the 30 Hz vibration component.

Impact spectra obtained on the AC generator inboard casing also indicate a structural natural frequency at approximately 62 Hz (Appendix I, Figure I6) which is close to 2 x synchronous speed (60 Hz). From Table 3, the maximum vibration level at 2 x synchronous frequency measured at the inboard bearing casing was 0.5 mm/s. This levels are considered acceptable. However, periodic monitoring of the AC generator casing vibration is recommended.

An impact spectrum obtained on the generator inboard bearing casing in the axial direction (Figure I7, Appendix I) shows a structural natural frequency at approximately 28.5 Hz. This natural frequency is relatively close to the synchronous speed and may amplify the casing response. The casing vibration levels in the axial direction (Table 3) are, however, acceptable.

### 4.6.2 Reduction Gearbox Structural Natural Frequencies

Impact spectra obtained on the reduction gearbox casing are shown in Figures I8 to I10 (Appendix I). Figure I9 shows a structural natural frequency at 61.5 Hz which is close to 2 x AC generator synchronous speed. However, the RGB casing vibration measured at the 60 Hz frequency is acceptable. Periodic monitoring of the RGB casing velocity levels is recommended.

### 4.6.3 Power Turbine Structural Natural Frequencies

Impact spectra obtained on the power turbine casing are shown in Figures I11 and I12 (Appendix I).

An impact spectrum obtained on the power turbine casing close to Bearing No 5 in the horizontal direction shows a structural natural frequency at approximately 29.5 Hz. This natural frequency is sufficiently close to the AC generator synchronous speed (30 Hz) and is likely amplifying the casing response at 30 Hz resulting in higher vibration amplitudes at this frequency.

### 4.6.4 Gas Producer Structural Natural Frequencies

Impact spectra obtained on the gas producer casing in the vicinity of Bearing No 2 are shown in Figures I13 and I14. No structural natural frequencies close to the gas producer operating speed are evident.

## 5.0 CONCLUSIONS

5.1 The overall shaft displacement and bearing casing velocity levels measured on the AC generator, at various loads ranging from 0 MW to 6.9 MW, are considered acceptable.

5.2 The overall velocity levels measured on the power turbine casing close to Bearing No 5 are considered unacceptable. The main vibration components are at 143 Hz (power turbine synchronous speed) and 30 Hz (AC generator synchronous speed). A structural natural frequency of the power turbine casing close to 30 Hz may be amplifying the casing response at this frequency.

5.3 The overall shaft displacement levels measured at the power turbine and gas producer bearings are considered acceptable at all loads tested.

5.4 Structural dynamics testing indicates that the AC generator has a structural natural frequency in the horizontal direction at approximately 32 Hz, as well as a natural frequency in the axial direction at approximately 28.5 Hz. These structural natural frequencies are relatively close to the AC generator synchronous speed (30 Hz).

The vibration levels measured on the AC generator casing are acceptable. However, increased levels of excitation at the synchronous frequency combined with the possible amplification of the casing response by these structural natural frequencies could result in unacceptable levels of vibration.

5.5 The reduction gearbox casing has a structural natural frequency at approximately 62 Hz which is close to twice the AC generator synchronous speed. However, the vibration amplitude of the 60 Hz component, measured on the RGB casing, is acceptable.

5.6 Impact spectra obtained on the gas producer casing (power turbine end) do not show any structural natural frequencies close to the gas producer speed.

5.7 A rotor critical speed of the AC generator was identified at approximately 1740 rpm (29 Hz) which is only 3% below the synchronous speed. This does not meet the requirement that critical speeds not be located between 15% below the minimum speed to 20% above the maximum continuous speed. However, the generator response at the critical speed appears to be relatively well damped and thus the critical speed is not likely to be a problem. No other critical speeds below 1950 rpm (overspeed) were identified.

5.8 Rotor critical speeds of the power turbine were identified at approximately 2810 rpm (47 Hz) and 3770 rpm (63 Hz). No other rotor critical speeds were identified below the power turbine speed of 9290 rpm.

5.9 Rotor critical speeds of the gas producer were identified at approximately 2660 rpm (44 Hz), 3025 rpm (50 Hz), 3900 rpm (65 Hz), 5000 rpm (83 Hz) and 5290 rpm (88 Hz). No other rotor critical speeds were identified below the gas producer speed of 11000 rpm.

## 6.0 RECOMMENDATIONS

6.1 Velocity spectra should be periodically obtained on the AC generator bearing casings to trend the 30 Hz component.

6.2 The manufacturer, Darlington Operations and Engineering, and Mechanical Research should discuss the feasibility of detuning the structural natural frequencies of the AC generator close to its synchronous speed.

6.3 Since the AC generator is operating close to a critical speed, displacement transducers should be installed at the AC generator bearings so that shaft vibration levels can be periodically monitored. A theoretical rotor dynamics analysis of the generator should be performed to determine the sensitivity of the generator to various parameters (eg, bearing clearances, unbalance distribution).

6.4 The manufacturer and the various engineering groups should discuss possible ways to reduce the high vibration levels measured on the power turbine casing close to Bearing No 5.

6.5 It is recommended that the reduction gearbox casing vibration be periodically monitored.

## ACKNOWLEDGMENTS

Mechanical Research technologist Mr W. Morgan is acknowledged for his assistance in reducing the data.

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## REFERENCES

1. N. Jagan, P. Hoogendam, "Darlington NGS 'A' Emergency Power Generator #2 Vibration Acceptance Tests", Ontario Hydro Research Division Report No. 90-310-K, 1991.

2. Solar Interoffice Memo, G. Cornejo to A. Criqui, April 12, 1988, "Darlington OH Mars GSC Allen Gearbox (RGB) Vibration".

3. Data supplied by Mr. K. Butt, Darlington NGS 'A' Operations.

## TABLE 1
## INSTRUMENTATION LIST

| | | |
|---|---|---|
| 1. | Accelerometer | Bruel & Kjaer Models 4368, 4384 |
| 2. | Displacement Transducer | Bently Nevada 7200 Series 5mm |
| 3. | Charge Amplifier | Bruel & Kjaer Model 2635 |
| 4. | Displacement Transducer Amplifier | Ontario Hydro Research |
| 5. | Dual Channel Analyzer | Ono Sokki CF 920 |
| 6. | Laserjet Printer | Texas Instruments - Omnilaser 2108 |
| 7. | Oscilloscope | Tektronix Model 2215 |
| 8. | Tape Recorder | Honeywell Model 101 |
| 9. | Tape Recorder | Hewlett Packard Model 3968A |
| 10. | Filter | Krohn-Hite Model 3343 |
| 11. | Vibration Calibrator | Bruel & Kjaer Model 4294 |
| 12. | Digital Vector Filter | Bently Nevada DVF 3 |
| 13. | Instrumented Tip Impact Hammer | PCB Piezotronics Inc, Model 086B50 |
| 14. | Digital Plotter | Hewlett-Packard Model 7470A |
| 15. | Photoelectric Tachometer Probe | Bruel & Kjaer MM 0024 |

## TABLE 2

## DARLINGTON NGS 'A' EMERGENCY POWER GENERATOR #1
## AC GENERATOR 1 x SYNCHRONOUS (30 Hz), 2 x SYNCHRONOUS AND OVERALL CASING VELOCITY LEVELS

| | AC Generator Outboard Bearing Casing Velocity Vertical Direction | | | | AC Generator Outboard Bearing Casing Velocity Horizontal Direction | | | |
|---|---|---|---|---|---|---|---|---|
| Load (MW) | 1 x Sync (30 Hz) mm/s pk | 2 x Sync (60 Hz) mm/s pk | Overall RMS mm/s | Overall Peak mm/s pk | 1 x Sync (30 Hz) mm/s pk | 2 x Sync (60 Hz) mm/s pk | Overall RMS mm/s | Overall Peak mm/s pk |
| ~0 | 0.31 | 0.14 | 0.3 | 0.7-0.8 | 2.80 | 0.24 | 1.9 | 3.1-3.3 |
| 1.0 | 0.33 | 0.16 | 0.4 | 0.9-1.0 | 2.71 | 0.35 | 1.9 | 3.1-3.5 |
| 2.0 | 0.48 | 0.05 | 0.4 | 0.9-1.0 | 2.94 | 0.30 | 2.0 | 3.3-3.7 |
| 3.0 | 0.49 | 0.03 | 0.5 | 1.0-1.1 | 2.51 | 0.34 | 1.7-1.8 | 3.1-3.2 |
| 4.0 | 0.50 | 0.03 | 0.4-0.5 | 1.0-1.1 | 2.32 | 0.26 | 1.6 | 2.9-3.1 |
| 5.0 | 0.52 | 0.03 | 0.5 | 1.1-1.2 | 2.36 | 0.21 | 1.6 | 2.9-3.1 |
| 6.0 | 0.53 | 0.03 | 0.5 | 1.0-1.2 | 2.33 | 0.19 | 1.6 | 2.9-3.1 |
| 6.9 | 0.53 | 0.04 | 0.5 | 1.0-1.2 | 2.34 | 0.15 | 1.6-1.7 | 2.9-3.2 |

## TABLE 3

### DARLINGTON NGS 'A' EMERGENCY POWER GENERATOR #1
### AC GENERATOR 1 x SYNCHRONOUS (30 Hz), 2 x SYNCHRONOUS AND OVERALL CASING VELOCITY LEVELS

| | AC Generator Inboard Bearing Casing Velocity Vertical Direction | | | | AC Generator Inboard Bearing Casing Velocity Horizontal Direction | | | | AC Generator Inboard Bearing Casing Velocity Axial Direction | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Load (MW) | 1 x Sync (30 Hz) mm/s pk | 2 x Sync (60 Hz) mm/s pk | Overall RMS mm/s | Overall Peak mm/s pk | 1 x Sync (30 Hz) mm/s pk | 2 x Sync (60 Hz) mm/s pk | Overall RMS mm/s | Overall Peak mm/s pk | 1 x Sync (30 Hz) mm/s pk | 2 x Sync (60 Hz) mm/s pk | Overall RMS mm/s | Overall Peak mm/s pk |
| ~0 | 0.14 | 0.25 | 0.3-0.4 | 0.7-0.9 | 1.94 | 0.10 | 1.4-1.5 | 2.5-2.9 | 0.23 | 0.21 | 0.4-0.5 | 0.7-1.4 |
| 1.0 | 0.11 | 0.26 | 0.4-0.5 | 1.0-1.3 | 1.76 | 0.23 | 1.4-1.5 | 3.6 | 0.29 | 0.27 | 0.5-0.6 | 0.8-1.5 |
| 2.0 | 0.21 | 0.14 | 0.4 | 0.9-1.1 | 1.59 | 0.43 | 1.3 | 2.2-2.3 | 0.58 | 0.17 | 0.5-0.6 | 1.0-1.3 |
| 3.0 | 0.22 | 0.09 | 0.4 | 1.0-1.2 | 1.26 | 0.48 | 1.1 | 2.1-2.3 | 0.60 | 0.16 | 0.6-0.8 | 1.9-2.2 |
| 4.0 | 0.27 | 0.05 | 0.5 | 1.0-1.2 | 1.11 | 0.37 | 1.0 | 2.2-2.6 | 0.66 | 0.11 | 0.3 | 1.9-2.7 |
| 5.0 | 0.35 | 0.05 | 0.5 | 1.0-1.2 | 1.17 | 0.31 | 1.0 | 2.3-2.6 | 0.77 | 0.09 | 0.3 | 1.9-2.7 |
| 6.0 | 0.40 | 0.05 | 0.5 | 1.0-1.3 | 1.20 | 0.27 | 1.1 | 2.4-2.8 | 0.83 | 0.09 | 0.7-0.8 | 1.3-1.8 |
| 6.9 | 0.45 | 0.05 | 0.5 | 1.1-1.3 | 1.27 | 0.22 | 1.1 | 2.6-2.8 | 0.88 | 0.08 | 0.7-0.8 | 1.2-1.6 |

## TABLE 4

### DARLINGTON NGS 'A' EMERGENCY POWER GENERATOR #1 REDUCTION GEARBOX (RGB) CASING VELOCITY LEVELS

| | RGB Casing Velocity Vertical Direction | | | RGB Casing Velocity Horizontal Direction | | | RGB Casing Velocity Axial Direction | | |
|---|---|---|---|---|---|---|---|---|---|
| Load (MW) | 143 Hz Component (mm/s pk) | Overall RMS (mm/s) | Overall Peak (mm/s pk) | 143 Hz Component (mm/s pk) | Overall RMS (mm/s) | Overall Peak (mm/s pk) | 143 Hz Component (mm/s pk) | Overall RMS (mm/s) | Overall Peak (mm/s pk) |
| ~ 0 | 0.37 | 0.8-0.9 | 2.1-2.8 | 1.02 | 1.5-1.6 | 3.7-4.2 | 0.26 | .98-1.0 | 2.3-3.2 |
| 1.0 | 0.42 | 1.0-1.1 | 2.5-2.6 | 1.54 | 2.1 | 5.4-6.4 | 0.20 | 1.2-1.5 | 2.7-3.9 |
| 2.0 | 0.57 | 1.0 | 2.4-2.7 | 2.60 | 2.2-2.3 | 4.7-5.2 | 0.09 | 1.0-1.1 | 2.4-2.9 |
| 3.0 | 0.46 | 0.9 | 2.3-2.9 | 2.59 | 2.2-2.3 | 4.8-5.2 | 0.09 | .91-.95 | 1.9-2.3 |
| 4.0 | 0.49 | 0.8 | 2.1-2.4 | 2.44 | 2.1-2.2 | 4.9-5.4 | 0.15 | .63 | 1.6-1.9 |
| 5.0 | 0.58 | 0.9 | 2.2-2.5 | 2.32 | 2.2 | 5.0-5.1 | 0.17 | .62 | 1.7-1.8 |
| 6.0 | 0.63 | 0.9 | 2.1-2.6 | 2.24 | 2.1 | 4.8-5.4 | 0.21 | .67 | 1.8-2.0 |
| 6.9 | 0.63 | 0.9 | 2.2-2.6 | 2.29 | 2.2 | 4.9-5.6 | 0.23 | .67-.69 | 1.8-2.1 |

## TABLE 5

### DARLINGTON NGS 'A' EMERGENCY POWER GENERATOR #1
### POWER TURBINE BEARING No 5 CASING VELOCITY LEVELS

| Load (MW) | Brg No 5 Casing Velocity Vertical Direction | | | | Brg No 5 Casing Velocity Horizontal Direction | | | | Brg No 5 Casing Velocity Axial Direction | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 30 Hz Component (mm/s pk) | 143 Hz Component (mm/s pk) | Overall RMS (mm/s) | Overall Peak (mm/s pk) | 30 Hz Component (mm/s pk) | 143 Hz Component (mm/s pk) | Overall RMS (mm/s) | Overall Peak (mm/s pk) | 30 Hz Component (mm/s pk) | 143 Hz Component (mm/s pk) | Overall RMS (mm/s) | Overall Peak (mm/s pk) |
| ~ 0 | 0.97 | 5.23 | 4.3-4.7 | 7.9-11.5 | 2.74 | 6.01 | 5.1-5.5 | 7.5-12.2 | 0.23 | 1.37 | 2.4 | 3.3-7.2 |
| 1.0 | 0.70 | 5.71 | 5.1-5.4 | 12-14 | 2.57 | 6.20 | 5.9-6.3 | 10-14.5 | 0.18 | 1.41 | 2.9-3.1 | 4.6-7.8 |
| 2.0 | 2.25 | 5.88 | 5.8-5.9 | 8.1-15.5 | 4.00 | 6.81 | 7.8-8.0 | 12-17 | 0.58 | 1.69 | 2.8-2.9 | 6.3-7.7 |
| 3.0 | 2.23 | 5.58 | 5.3-5.4 | 13.3-14.8 | 3.48 | 5.95 | 6.1-6.5 | 16.7-17.9 | 0.58 | 1.62 | 2.4-2.7 | 7.8-8.1 |
| 4.0 | 2.65 | 5.61 | 5.2-5.4 | 6.0-12 | 3.21 | 5.46 | 6.0-6.6 | 9.0-17 | 0.64 | 1.48 | 4.1-4.2 | 6.1-8.7 |
| 5.0 | 2.83 | 5.60 | 5.1-5.2 | 11.6-14.1 | 3.10 | 5.11 | 5.5-6.0 | 11.8-14.7 | 0.70 | 1.51 | 6.0-6.2 | 10.3-11.5 |
| 6.0 | 3.26 | 5.73 | 5.3-5.6 | 8.2-14 | 3.20 | 5.31 | 5.4-5.6 | 11.5-15.2 | 0.76 | 1.59 | 3.1-3.4 | 6.8-8.1 |
| 6.9 | 3.00 | 5.88 | 5.3-5.7 | 9.8-13 | 2.76 | 5.67 | 5.4-5.8 | 8.5-15 | 0.75 | 2.55 | 1.9-3.4 | 3.0-6.8 |

Power Turbine Synchronous Speed = 143 Hz approximately
AC Generator Synchronous Speed = 30 Hz

## TABLE 6

## DARLINGTON NGS 'A' EMERGENCY POWER GENERATOR #1 ACCESSORY GEARBOX (AGB) OVERALL CASING VELOCITY LEVELS

| Load (MW) | AGB Casing Velocity Horizontal Direction | |
|---|---|---|
| | Overall RMS (mm/s) | Overall Peak (mm/s pk) |
| 0 | 0.8–0.9 | 1.3–2.0 |
| 1.0 | 0.8–1.0 | 1.6–2.8 |
| 2.0 | 1.0–1.1 | 2.2–3.0 |
| 3.0 | 0.9–1.0 | 3.0–3.8 |
| 4.0 | 0.9–1.0 | 1.2–2.4 |
| 5.0 | 0.8–0.9 | 1.2–2.6 |
| 6.0 | 0.9–1.2 | 1.5–2.9 |
| 6.9 | 0.9–1.2 | 1.6–2.9 |

## TABLE 7

### DARLINGTON NGS 'A' EMERGENCY POWER GENERATOR #1
### AC GENERATOR 1 x SYNCHRONOUS (30 Hz), 2 x SYNCHRONOUS, AND OVERALL SHAFT DISPLACEMENT LEVELS

|  | AC Generator Outboard Bearing Shaft Displacement Vertical Direction (μm p-p) |  |  | AC Generator Outboard Bearing Shaft Displacement Horizontal Direction (μm p-p) |  |  | AC Generator Inboard Bearing Shaft Displacement Vertical Direction (μm p-p) |  |  | AC Generator Inboard Bearing Shaft Displacement Horizontal Direction (μm p-p) |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Load (MW) | 1 x Sync (30 Hz) | 2 x Sync (60 Hz) | Overall | 1 x Sync (30 Hz) | 2 x Sync (60 Hz) | Overall | 1 x Sync (30 Hz) | 2 x Sync (60 Hz) | Overall | 1 x Sync (30 Hz) | 2 x Sync (60 Hz) | Overall |
| ~ 0 | 21.1 | 7.3 | 27 | 13.0 | 9.1 | 25 | 9.1 | 7.7 | 21-23 | 1.4 | 5.9 | 18-21 |
| 1.0 | 22.0 | 7.5 | 29 | 14.2 | 9.8 | 27 | 9.1 | 8.5 | 34 | 0.7 | 7.2 | 29-38 |
| 2.0 | 24.0 | 7.0 | 29 | 18.7 | 9.9 | 28 | 4.7 | 5.1 | 17 | 5.2 | 5.2 | 20 |
| 3.0 | 24.0 | 7.1 | 29 | 21.0 | 10.4 | 30 | 5.4 | 4.4 | 17 | 3.1 | 5.5 | 18 |
| 4.0 | 25.2 | 7.0 | 30 | 21.6 | 10.8 | 31 | 2.6 | 4.7 | 17 | 1.7 | 5.9 | 18 |
| 5.0 | 26.8 | 6.7 | 31 | 23.6 | 11.4 | 33 | 2.7 | 4.6 | 18 | 3.7 | 6.2 | 19 |
| 6.0 | 27.6 | 6.5 | 32 | 24.8 | 11.8 | 34 | 4.0 | 4.5 | 18 | 5.2 | 6.4 | 19 |
| 6.9 | 28.8 | 6.2 | 33 | 25.7 | 12.2 | 35 | 5.6 | 4.3 | 18 | 7.2 | 6.7 | 20 |

## TABLE 8

## DARLINGTON NGS 'A' EMERGENCY POWER GENERATOR #1

## POWER TURBINE 1 x SYNCHRONOUS (143 Hz), 30 Hz COMPONENT, AND OVERALL SHAFT DISPLACEMENT LEVELS

| Load (MW) | Power Turbine Bearing No 4 Shaft Displacement Vertical Direction ($\mu$m p-p) | | | Power Turbine Bearing No 4 Shaft Displacement Horizontal Direction ($\mu$m p-p) | | | Power Turbine Bearing No 5 Shaft Displacement Vertical Direction ($\mu$m p-p) | | | Power Turbine Bearing No 5 Shaft Displacement Horizontal Direction ($\mu$m p-p) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 x Sync | 30 Hz Component | Overall | 1 x Sync | 30 Hz Component | Overall | 1 x Sync | 30 Hz Component | Overall | 1 x Sync | 30 Hz component | Overall |
| ~0 | 3.9 | 2.0 | 10 | 4.7 | 1.2 | 11 | 7.2 | 2.6 | 12 | 10.0 | 1.7 | 17 |
| 1.0 | 2.6 | 1.9 | 10 | 3.2 | 1.1 | 10 | 7.3 | 2.7 | 15 | 9.7 | 1.9 | 17 |
| 2.0 | 1.2 | 4.6 | 10 | 1.9 | 1.0 | 7 | 7.2 | 5.7 | 15 | 10.3 | 3.3 | 20 |
| 3.0 | 1.9 | 4.3 | 10 | 1.9 | 0.9 | 7 | 6.4 | 6.1 | 14 | 9.0 | 2.7 | 14 |
| 4.0 | 2.2 | 4.3 | 9 | 1.9 | 1.8 | 6 | 6.3 | 6.1 | 19 | 8.2 | 1.9 | 15 |
| 5.0 | 2.1 | 4.3 | 9 | 1.8 | 2.5 | 8 | 5.9 | 6.3 | 18 | 7.4 | 1.9 | 11 |
| 6.0 | 1.9 | 4.4 | 10 | 1.9 | 3.0 | 9 | 6.1 | 6.9 | 17 | 7.4 | 1.6 | 12 |
| 6.9 | 2.3 | 4.6 | 11 | 2.1 | 2.3 | 7 | 6.4 | 6.7 | 17 | 7.7 | 3.4 | 14 |

## TABLE 9

### DARLINGTON NGS 'A' EMERGENCY POWER GENERATOR #1
### GAS PRODUCER 1 x SYNCHRONOUS*, 2 x SYNCHRONOUS, AND OVERALL SHAFT DISPLACEMENT LEVELS

| Load (MW) | Gas Producer Bearing No 1 Shaft Displacement Vertical Direction (μm p-p) | | | Gas Producer Bearing No 1 Shaft Displacement Horizontal Direction (μm p-p) | | | Gas Producer Bearing No 2 Shaft Displacement Vertical Direction (μm p-p) | | | Gas Producer Bearing No 2 Shaft Displacement Horizontal Direction (μm p-p) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 x Sync | 2 x Sync | Overall | 1 x Sync | 2 x Sync | Overall | 1 x Sync | 2 x Sync | Overall | 1 x Sync | 2 x Sync | Overall |
| ~ 0 | 5.7 | 0.5 | 10 | 5.2 | 0.3 | 9 | 18.2 | 3.7 | 22 | 17.8 | 2.6 | 21 |
| 1.0 | 6.8 | 0.4 | 10 | 5.9 | 0.4 | 9 | 19.6 | 4.0 | 24 | 19.8 | 2.7 | 25 |
| 2.0 | 5.5 | 0.5 | 9 | 4.5 | 0.3 | 8 | 20.8 | 4.3 | 28 | 20.3 | 2.8 | 27 |
| 3.0 | 5.6 | 0.5 | 8 | 3.6 | 0.5 | 6 | 22.0 | 4.6 | 28 | 22.1 | 2.7 | 28 |
| 4.0 | 6.5 | 0.4 | 11 | 4.1 | 0.5 | 7 | 22.6 | 4.5 | 29 | 23.0 | 2.5 | 29 |
| 5.0 | 8.2 | 0.5 | 11 | 5.5 | 0.5 | 9 | 28.7 | 4.5 | 30 | 29.1 | 2.4 | 34 |
| 6.0 | 5.5 | 0.5 | 9 | 4.0 | 0.6 | 7 | 25.3 | 4.5 | 32 | 25.6 | 2.4 | 34 |
| 6.9 | 5.9 | 0.4 | 10 | 4.8 | 0.6 | 8 | 25.4 | 4.2 | 32 | 25.9 | 2.3 | 33 |

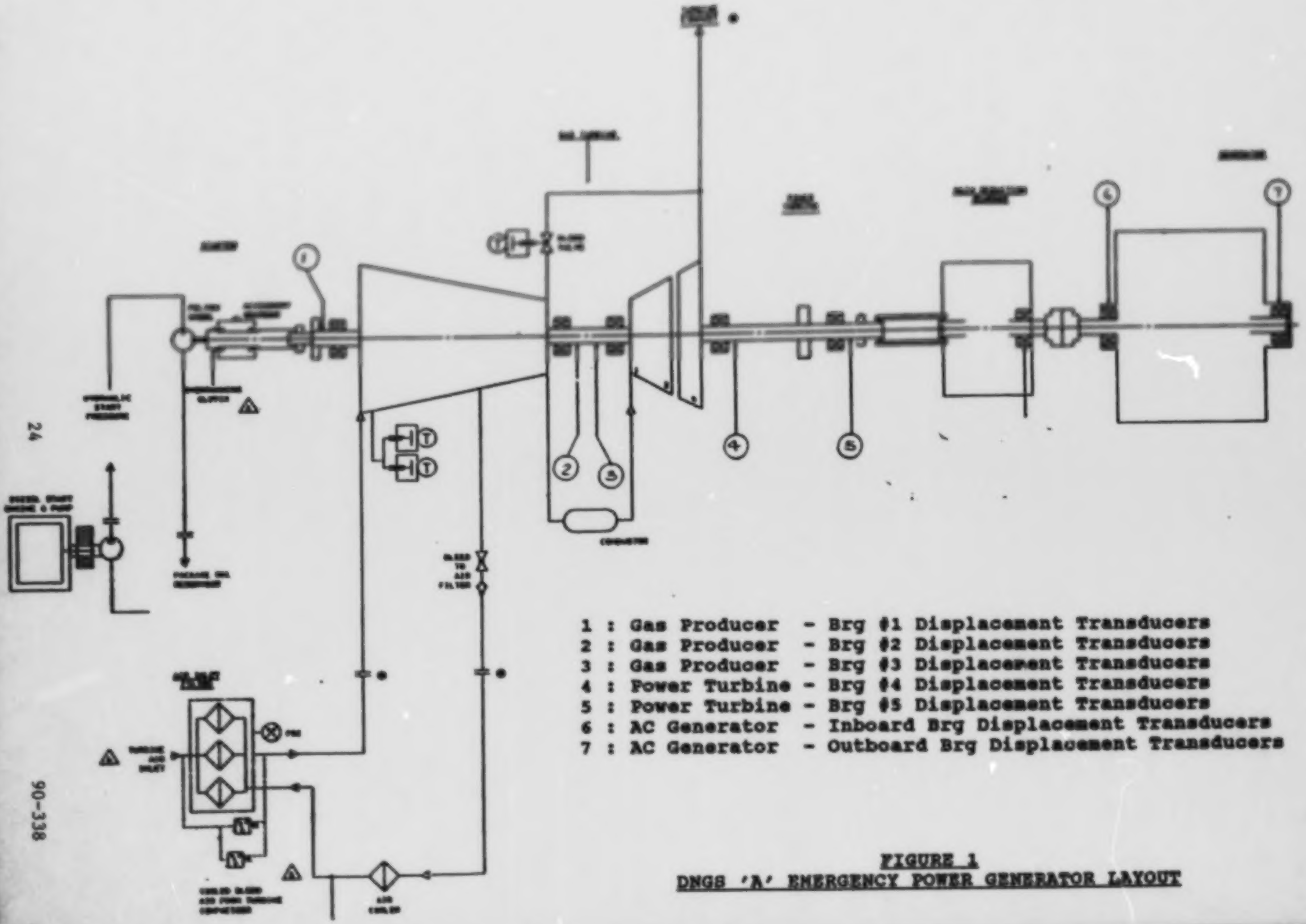
* Gas Producer Synchronous Speed = 8906 rpm (148.4 Hz) to 10270 rpm (171.2 Hz) depending on load

## TABLE 10

## DARLINGTON NGS 'A' EMERGENCY POWER GENERATOR #1
## GAS PRODUCER 1 x SYNCHRONOUS*, 2 x SYNCHRONOUS, AND OVERALL SHAFT DISPLACEMENT LEVELS

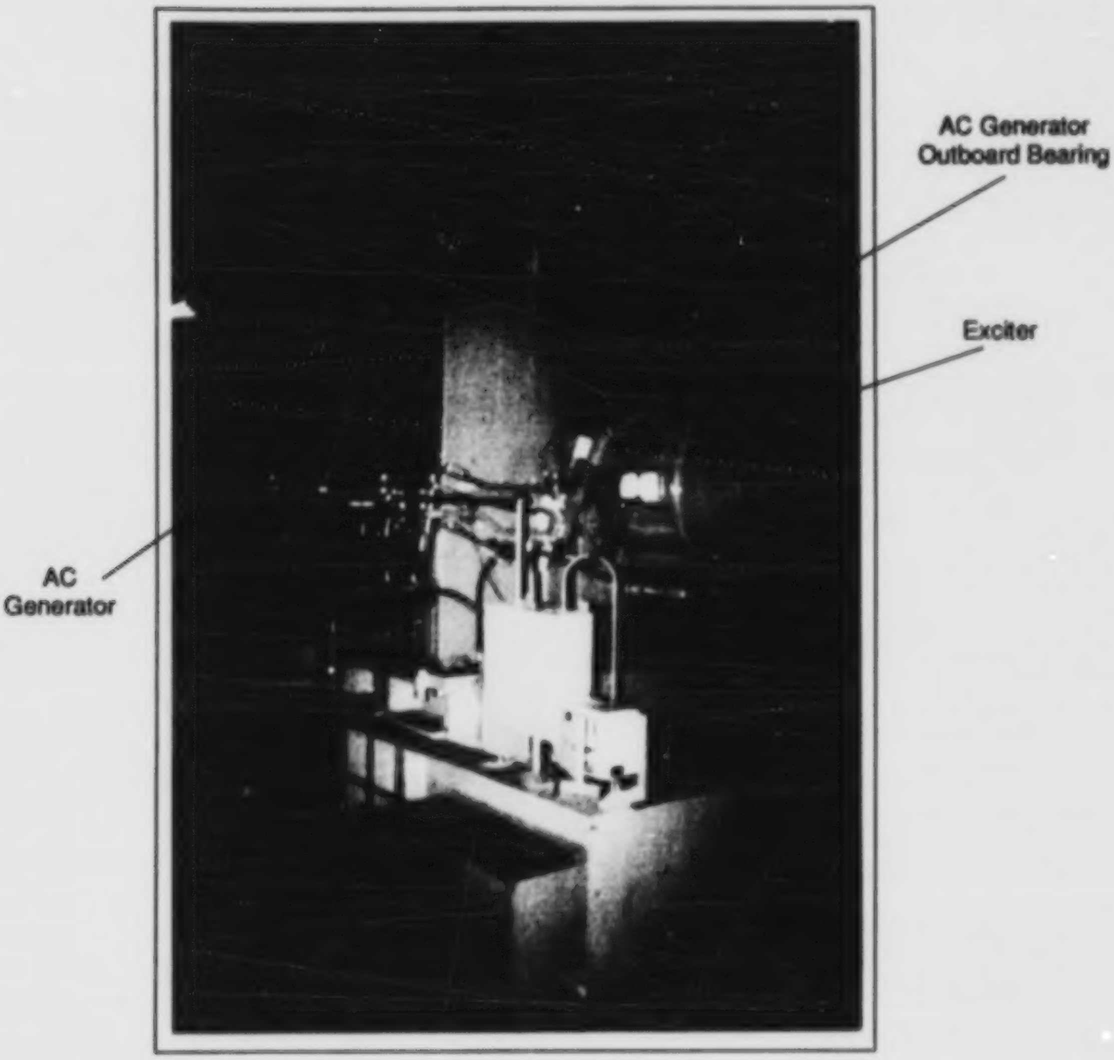
|  | Gas Producer Bearing No 3 Shaft Displacement Vertical Direction (μm p-p) |  |  | Gas Producer Bearing No 3 Shaft Displacement Horizontal Direction (μm p-p) |  |  |
|---|---|---|---|---|---|---|
| Load (MW) | 1 x Sync | 2 x Sync | Overall | 1 x Sync | 2 x Sync | Overall |
| ~ 0 | 7.3 | 1.2 | 11 | 7.4 | 1.2 | 11 |
| 1.0 | 8.6 | 1.2 | 14 | 9.0 | 1.3 | 12 |
| 2.0 | 10.8 | 1.2 | 17 | 9.5 | 1.4 | 15 |
| 3.0 | 12.5 | 1.3 | 18 | 10.8 | 1.5 | 18 |
| 4.0 | 13.4 | 1.3 | 20 | 13.4 | 1.5 | 17 |
| 5.0 | 15.8 | 1.3 | 19 | 15.5 | 1.4 | 19 |
| 6.0 | 13.9 | 1.2 | 21 | 13.8 | 1.5 | 19 |
| 6.9 | 14.7 | 1.4 | 22 | 14.5 | 1.5 | 21 |

* Gas Producer Synchronous Speed = 8906 rpm (148.4 Hz) to 10270 rpm (171.2 Hz) depending on load



1 : Gas Producer - Brg #1 Displacement Transducers
2 : Gas Producer - Brg #2 Displacement Transducers
3 : Gas Producer - Brg #3 Displacement Transducers
4 : Power Turbine - Brg #4 Displacement Transducers
5 : Power Turbine - Brg #5 Displacement Transducers
6 : AC Generator - Inboard Brg Displacement Transducers
7 : AC Generator - Outboard Brg Displacement Transducers

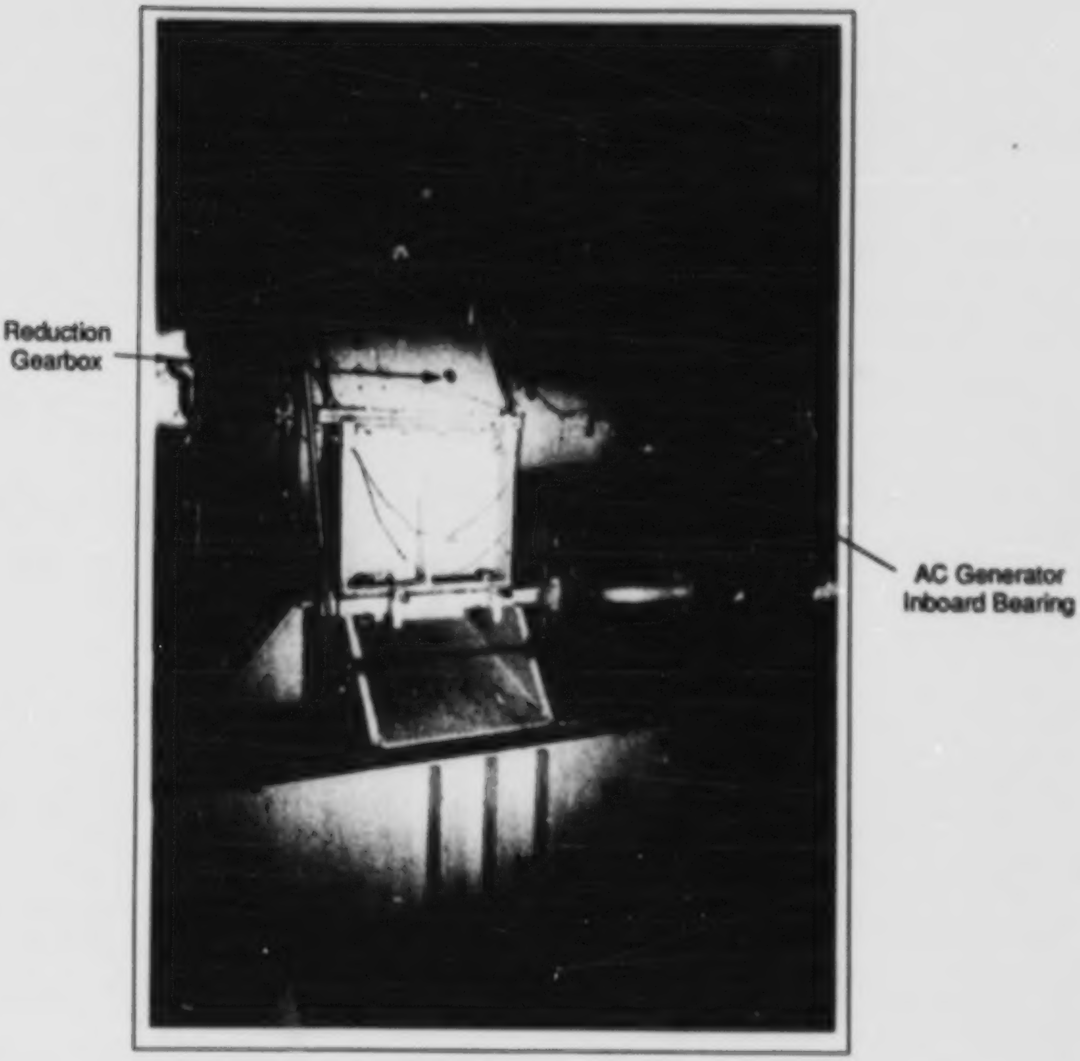
**FIGURE 1**
**DNGS 'A' EMERGENCY POWER GENERATOR LAYOUT**


AC Generator Outboard Bearing
Exciter
AC Generator

(a) AC Generator

FIGURE 2

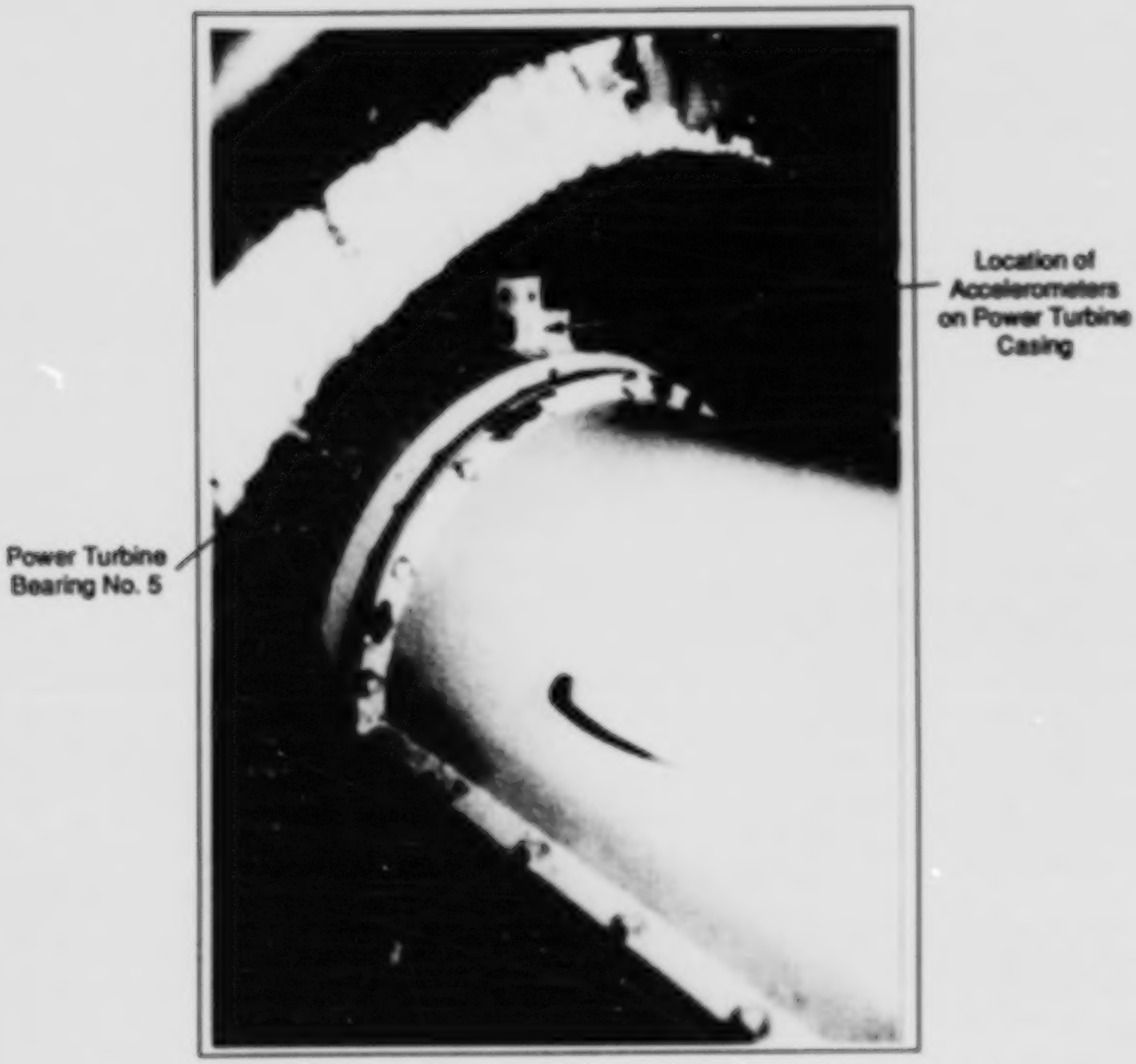
DNGS 'A' EMERGENCY POWER GENERATOR


Reduction Gearbox
AC Generator Inboard Bearing

(b) Reduction Gear Box

FIGURE 2

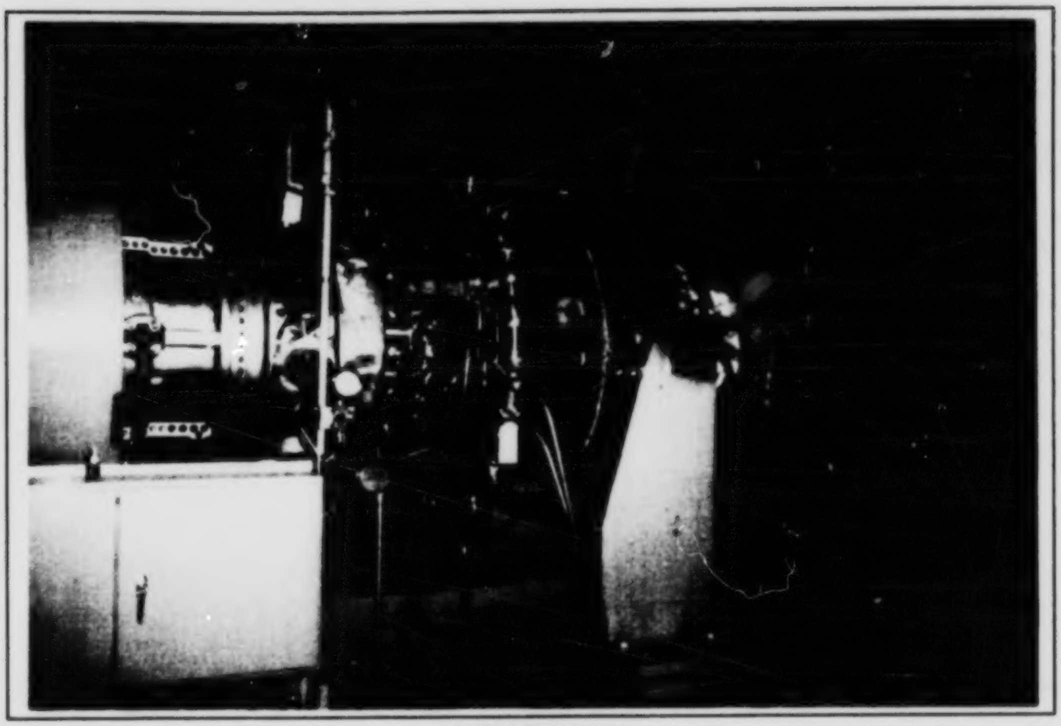
DNGS 'A' EMERGENCY POWER GENERATOR


Location of Accelerometers on Power Turbine Casing
Power Turbine Bearing No. 5

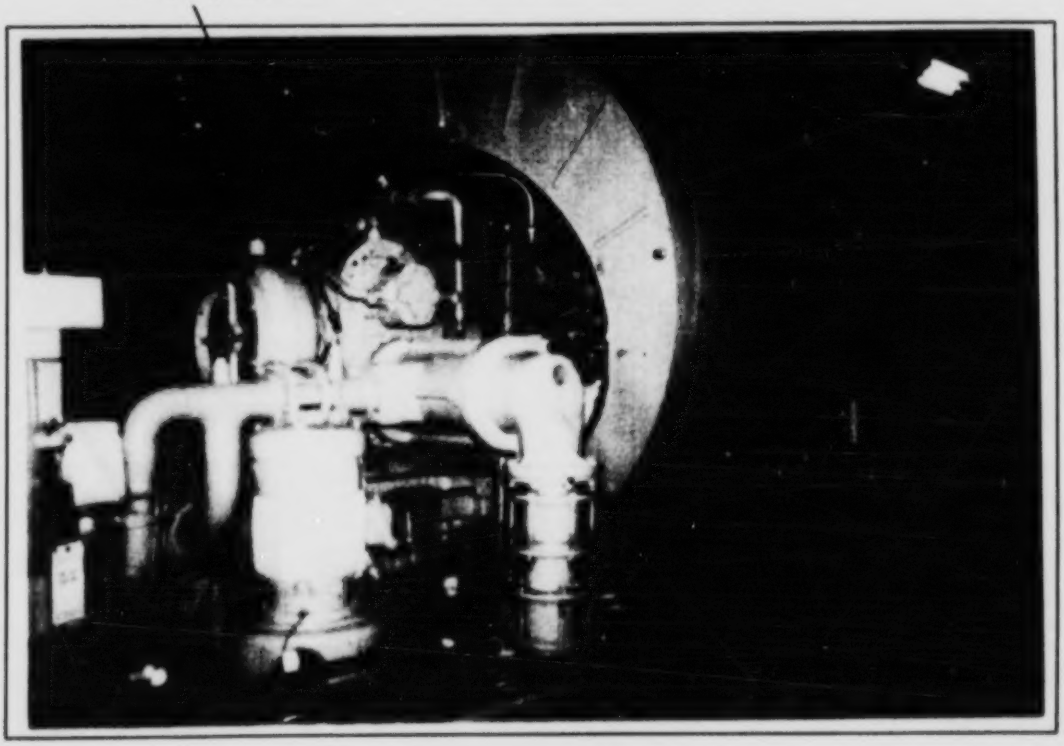
(c) Power Turbine Casing Near Bearing No. 5

FIGURE 2

DNGS 'A' EMERGENCY POWER GENERATOR



(d) Gas Producer


Accessory Gearbox

(e) Accessory Gearbox

FIGURE 2

DNGS 'A' EMERGENCY POWER GENERATOR

90-338

184979-B27-RD

# APPENDIX A

## DESCRIPTION OF TURBINE-GENERATOR SET

# SECTION 1

# TURBINE-DRIVEN GENERATOR SET

## 1.1 GENERAL

The basic turbine-driven generator set (figure 1.1), comprises a Mars two-shaft industrial turbine engine, a speed-reducing gear unit, a generator, a diesel engine-operated hydraulic start system, a package-mounted gage panel, and a floor-standing control console. The console contains most electrical control devices and circuitry necessary for engine and generator operation and protection.

Additional equipment furnished with this generator set, include the batteries and battery chargers for the 24-volt and 120-volt dc systems,the liquid fuel boost assembly, oil cooler assembly and the air intake and exhaust assemblies with associated ducting.

The engine, gearbox, and generator constitute the major elements of the generator set, and are installed on a rigid two-section steel base frame, in an in-line arrangement, with the generator occupying the smaller aft section. Each base frame is a structural steel assembly with beam sections and cross-members welded together, to form a rigid foundation for the engine assembly and driven equipment. Both base sections are provided with heavy mounting flange, and are securely bolted together.

Power from the engine power turbine rotor is transmitted to the reduction gear unit by a tubular output drive shaft. The output drive shaft is enclosed in a two-piece protective oil-tight cover.

The generator input shaft is aligned with the reduction gear unit output shaft, and the two shafts are connected by a limited end float coupling assembly enclosed in a protective safety cover.

An accessory drive assembly for the operation of engine-driven pumps and other accessories that require specific rotational input speeds is included as a separate base-mounted unit. It is located on the engine base section, forward of the engine air inlet, and is connected to the engine compressor nose cone hub by means of a tubular shaft, enclosed in a protective cover.

The generator set is a fully operational package, equipped with all accessories necessary for normal operation when connected to a customer's facilities. It incorporates a full complement of auxiliary systems, including a complete fuel system, an air system with associated devices, a lubricating oil system with related subsystems, a diesel engine-operated hydraulic start system and an electrical control system.

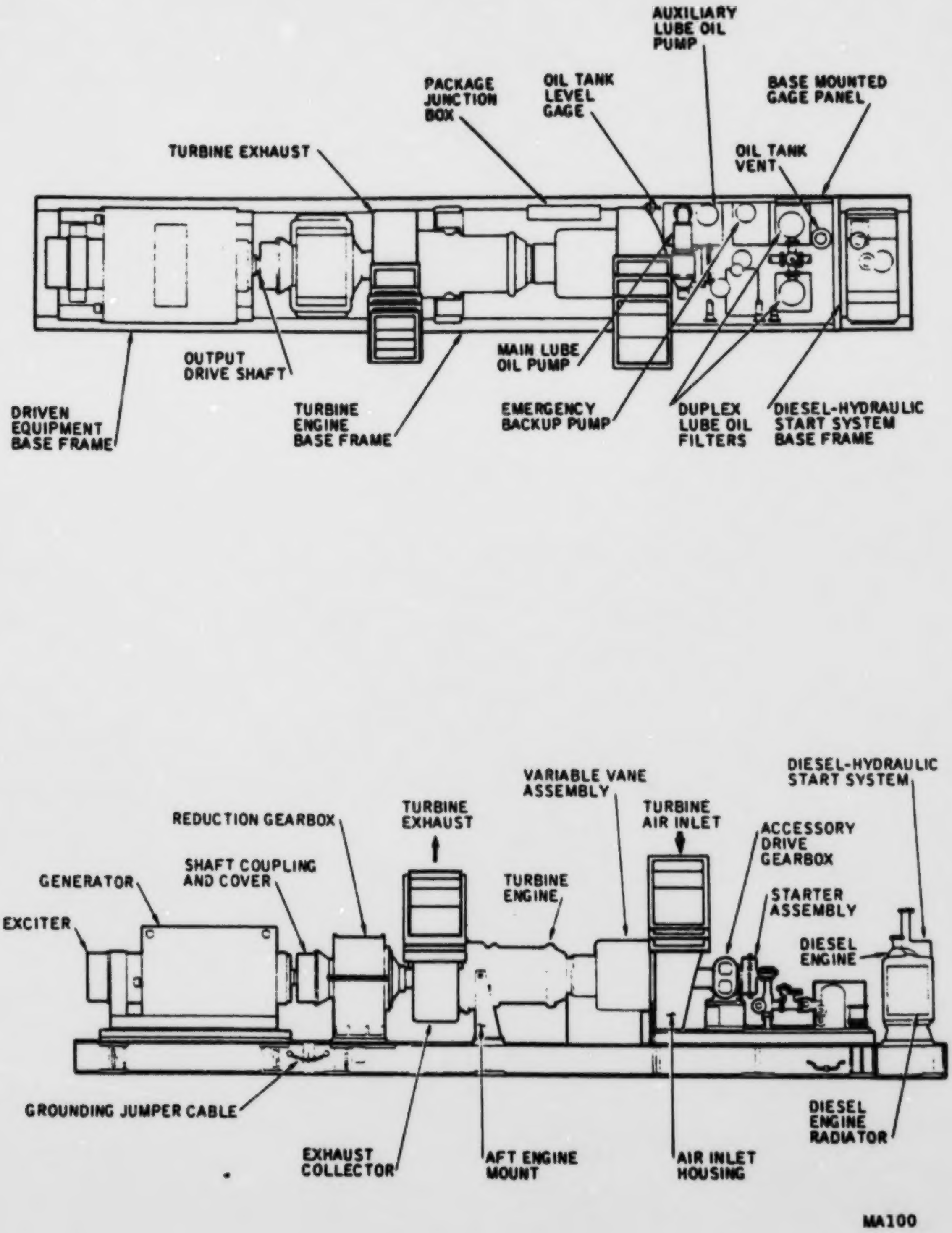

AUXILIARY LUBE OIL PUMP
PACKAGE JUNCTION BOX
OIL TANK LEVEL GAGE
BASE MOUNTED GAGE PANEL
TURBINE EXHAUST
OIL TANK VENT
OUTPUT DRIVE SHAFT
MAIN LUBE OIL PUMP
DRIVEN EQUIPMENT BASE FRAME
TURBINE ENGINE BASE FRAME
EMERGENCY BACKUP PUMP
DUPLEX LUBE OIL FILTERS
DIESEL-HYDRAULIC START SYSTEM BASE FRAME
DIESEL-HYDRAULIC START SYSTEM
VARIABLE VANE ASSEMBLY
TURBINE EXHAUST
TURBINE AIR INLET
REDUCTION GEARBOX
ACCESSORY DRIVE GEARBOX
SHAFT COUPLING AND COVER
GENERATOR
TURBINE ENGINE
STARTER ASSEMBLY
EXCITER
DIESEL ENGINE
GROUNDING JUMPER CABLE
DIESEL ENGINE RADIATOR
EXHAUST COLLECTOR
AFT ENGINE MOUNT
AIR INLET HOUSING
MA100

Figure 1.1. Typical Mars Generator Set Outline

## 1.2 TURBINE ENGINE

The Mars T-MA-2 turbine engine is of a two-shaft, variable speed, axial-flow design, consisting of a separately mounted accessory drive assembly, air inlet assembly, 15-stage compressor with fixed and variable guide vane assemblies, compressor diffuser assembly, combustor assembly with annular combustion chamber, two-stage gas producer turbine, two-stage power turbine, turbine exhaust diffuser, and exhaust collector. These major components are maintained in accurate alignment by mating flange with pilot surfaces and are bolted together to form a rigid assembly. The power turbine transmits driving power to the driven equipment (i.e., reduction gear unit and generator) through a tubular drive shaft, enclosed in a protective cover. The driven equipment input shaft is carefully aligned with the power turbine output drive shaft, which is firmly supported within the power turbine bearing housing, with the housing attached to the exhaust diffuser in the power turbine section. The engine compressor nose cone hub is also carefully aligned and connected to the input shaft of the separately mounted accessory drive assembly at the forward end of the engine, by means of a short, tubular and enclosed drive shaft.

**Note**

Reference locations of components on the engine and entire compressor set are forward, aft, right and left. These directions are established by viewing the set from the driven equipment (aft) end.

## 1.3 SYSTEMS

The fuel system controls the fuel pressure and automatically regulates the fuel flow according to operating requirements.

The air system pressurizes oil seals in the turbine engine, cools the turbine section components,and bypasses a controlled amount of engine compressor discharge air during starting and low power operation to avoid surge conditions.

The start system comprises a diesel engine, driving a hydraulic pump which provide the necessary hydraulic power to operate a Pelton wheel-type turbine starter, together with associated control devices that enable the engine to crank and accelerate smoothly to 65 percent engine speed at which time the start system shuts down, the starter clutch overruns, and the engine accelerates under its own power to operating (no load) speed.

The lubricating oil system circulates oil under pressure to the various working parts of the turbine engine and driven equipment. In addition, the system supplies oil at engine inlet pressure to related hydraulic subsystems. The system is supplied from an oil tank, located in the base frame. Proper oil temperatures are maintained by an oil cooler and thermostatic valves, and by oil tank heaters. The oil cooler is remotely installed, and a number of optional installation plans are available, depending on station requirements.

The servo oil system provides oil pressure to operate actuating and control devices in the variable inlet guide vane, bleed air valve, and fuel control actuator subsystems.

The electrical control system, operating on 24-volt dc power, provides for automatic starting, acceleration to operating speed, engine and driven equipment monitoring during operating, and normal and emergency (malfunction) shutdown. During operation, the electrical control system, by means of automatic warning and shutdown devices, protects the turbine engine and driven equipment from possible damage resulting from hazards such as overspeed, high engine temperatures, low lubricating oil pressure, low oil level, excessive oil temperature, and generator malfunction. Other malfunction shutdown devices are provided, and special devices may be added according to application requirements.

The electrical control system is operated from a remotely installed control console, incorporating a turbine engine control panel and a generator metering panel with all necessary switches, pushbuttons, meters and indicators for engine and generator operational status. The free-standing control console may be installed in a separate control room, in accordance with installation requirements. Remote operation of the generator set is also possible upon completion of minor changes in the dc control system wiring in accordance with the electrical system schematic.

## 1.4 REDUCTION GEAR UNIT

The reduction gear unit used with the Mars generator set has an epicyclic star gear design. Assembly and disassembly is simplified by a split housing, the upper half of which can be removed easily for inspection and maintenance. The gears can be completely serviced without moving the lower case housing.

The gear unit is designed for a maximum input of 10 440 kW (14 000 hp) at an output speed of 1800 rpm for 60 Hz generator operation.

The gear unit is mounted on the engine base and coupled to the engine through a balanced high speed shaft, splined at both ends. The shaft is a matched part of the gear unit. The output shaft is coupled to the generator through a gear coupling with limited end float. Gear lubrication is from the main turbine oil system, and output shaft seal air is supplied by the turbine.

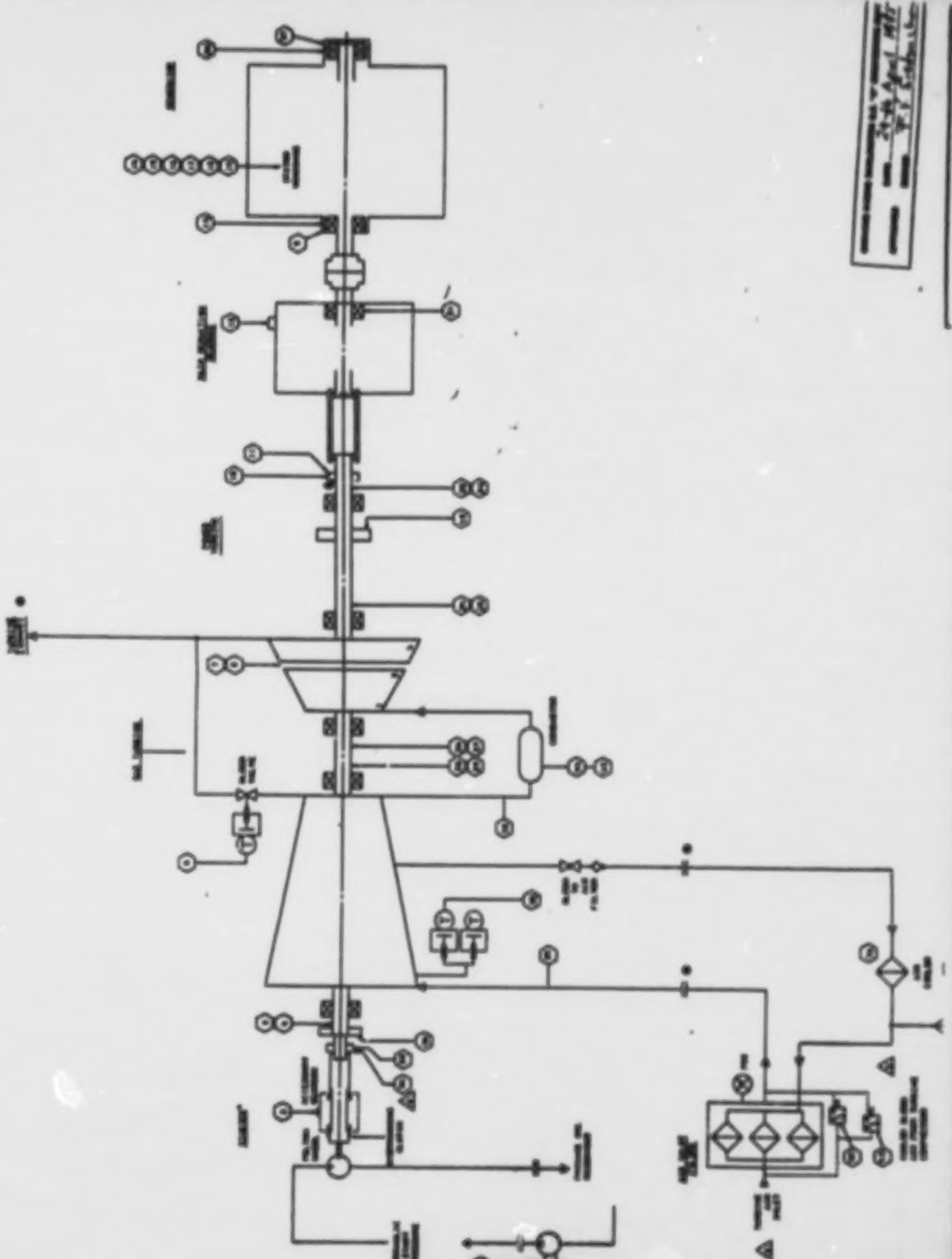
## 1.5 GENERATOR

The generator is mounted on a steel base separate from the base containing the turbine engine and the reduction gear unit. The generator base, aligned and matchmarked to the engine base at the factory, is bolted to the engine base. The generator is positioned in alignment with the reduction gear unit by means of shims and adjustment screws, and bolted in place.

The generator is a two-bearing (sleeve-type), self-ventilated, air-cooled, three-phase, 4160 Vac, 60 Hz, 1800 rpm, ac generator of drip-proof construction, equipped with a brushless type exciter using a rotating rectifier bridge circuit. The rectifier is mounted on the rotor shaft and supplies the field excitation current for the generator.

## 1.6 ENVIRONMENT

The standard turbine generator set is designed for operation (when installed in a weather-proof enclosure) at seal level and up to 2438 meters (8000 feet) elevation, at engine air inlet (ambient) temperatures ranging from -29°C (-20°F) to +43°C (-110°F). Special accessories are necessary for operation at higher elevations or in extreme temperature, salt or dust conditions. The type of lubricating oil used may cause restrictions on operation in extreme temperatures. In particular, the lubricating oil contained in the oil tank, oil lines, engine and oil cooler should have suitable minimum and maximum viscosities for the ambient starting temperature.



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# APPENDIX B

# AC GENERATOR VELOCITY AND DISPLACEMENT SPECTRA

### TABLE B1

### DARLINGTON NGS 'A' EMERGENCY POWER GENERATOR #1 - AC GENERATOR
### FIGURE NUMBERS OF VELOCITY AND DISPLACEMENT SPECTRA

| Measurement | | FFT Spectrum Figure No. Load (MW) 0 | 1 | 2 | 3 | 4 | 5 | 6 | 6.9 |
|---|---|---|---|---|---|---|---|---|---|
| Outboard Bearing Casing Velocity | Vertical Direction | B1 | B2 | B3 | B4 | B5 | B6 | B7 | B8 |
| | Horizontal Direction | B9 | B10 | B11 | B12 | B13 | B14 | B15 | B16 |
| Inboard Bearing Casing Velocity | Vertical Direction | B17 | B18 | B19 | B20 | B21 | B22 | B23 | B24 |
| | Horizontal Direction | B25 | B26 | B27 | B28 | B29 | B30 | B31 | B32 |
| | Axial Direction | B32 | B34 | B35 | B36 | B37 | B38 | B39 | B40 |
| Outboard Bearing Shaft Displacement | Vertical Direction | B41 | B42 | B43 | B44 | B45 | B46 | B47 | B48 |
| | Horizontal Direction | B49 | B50 | B51 | B52 | B53 | B54 | B55 | B56 |
| Inboard Bearing Shaft Displacement | Vertical Direction | B57 | B58 | B59 | B60 | B61 | B62 | B63 | B64 |
| | Horizontal Direction | B65 | B66 | B67 | B68 | B69 | B70 | B71 | B72 |

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator OB Brg Casing Vel. Vert.
PROCESS CONDITION : Load 0.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 0.31 |
| 2 | 120.3 | 0.16 |
| 3 | 60.1 | 0.14 |
| 4 | 75.8 | 0.08 |
| 5 | 113.0 | 0.05 |
| 6 | 105.8 | 0.04 |
| 7 | 143.1 | 0.03 |
| 8 | 102.2 | 0.03 |
| 9 | 149.1 | 0.03 |
| 10 | 90.2 | 0.02 |

SCALE: Linear DATE: 11-08-88

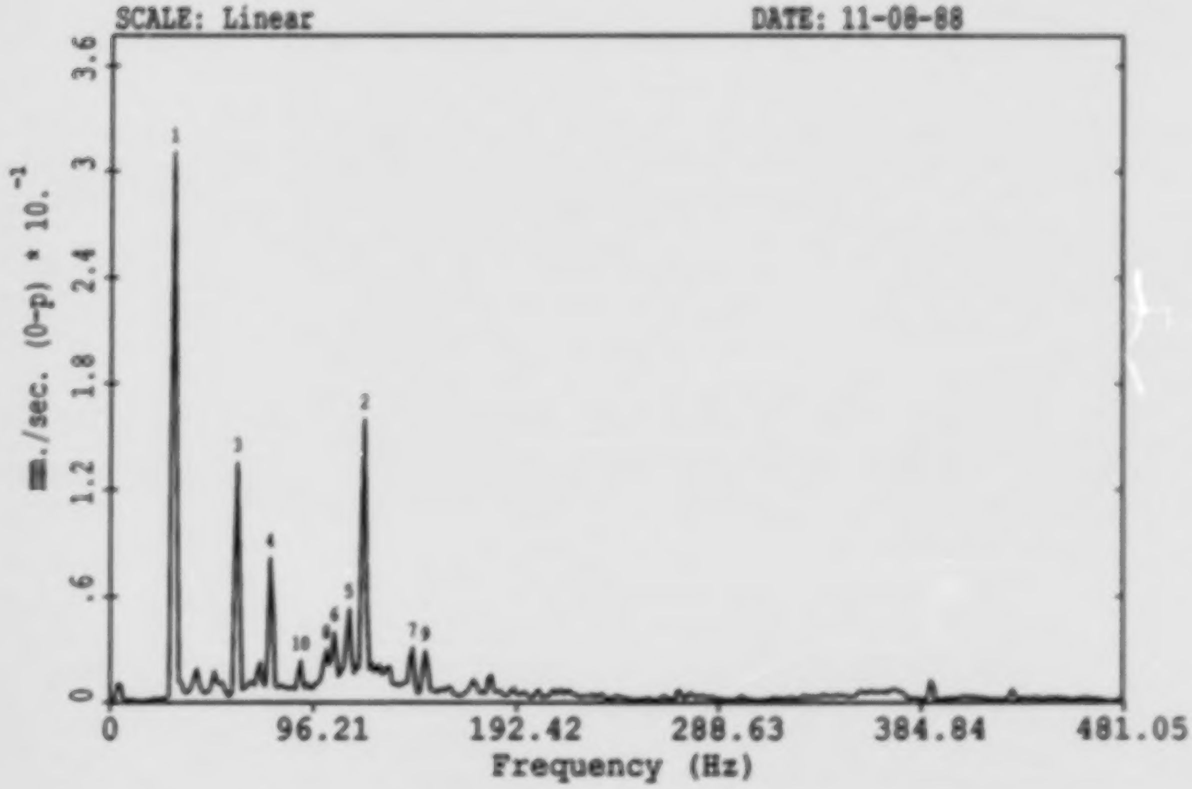


FIGURE B1

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator OB Brg Casing Vel. Vert.
PROCESS CONDITION : Load 1.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 0.33 |
| 2 | 50.5 | 0.22 |
| 3 | 60.1 | 0.16 |
| 4 | 120.3 | 0.13 |
| 5 | 75.8 | 0.12 |
| 6 | 110.6 | 0.10 |
| 7 | 105.8 | 0.09 |
| 8 | 80.6 | 0.06 |
| 9 | 115.5 | 0.06 |
| 10 | 55.3 | 0.05 |

SCALE: Linear

DATE: 11-08-88

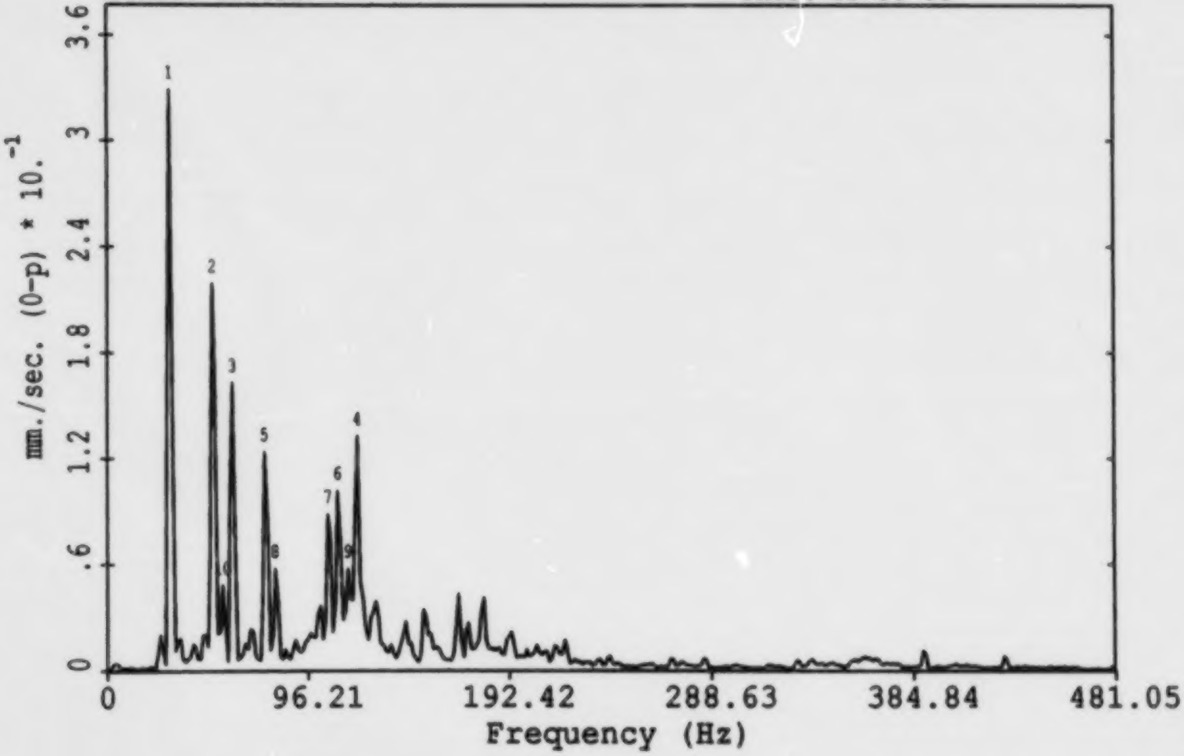


FIGURE B2

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator OB Brg Casing Vel. Vert.
PROCESS CONDITION : Load 2.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 0.48 |
| 2 | 120.3 | 0.23 |
| 3 | 75.8 | 0.13 |
| 4 | 143.1 | 0.07 |
| 5 | 196.0 | 0.06 |
| 6 | 113.0 | 0.06 |
| 7 | 173.2 | 0.06 |
| 8 | 90.2 | 0.05 |
| 9 | 180.4 | 0.05 |
| 10 | 60.1 | 0.05 |

SCALE: Linear

DATE: 11-08-88

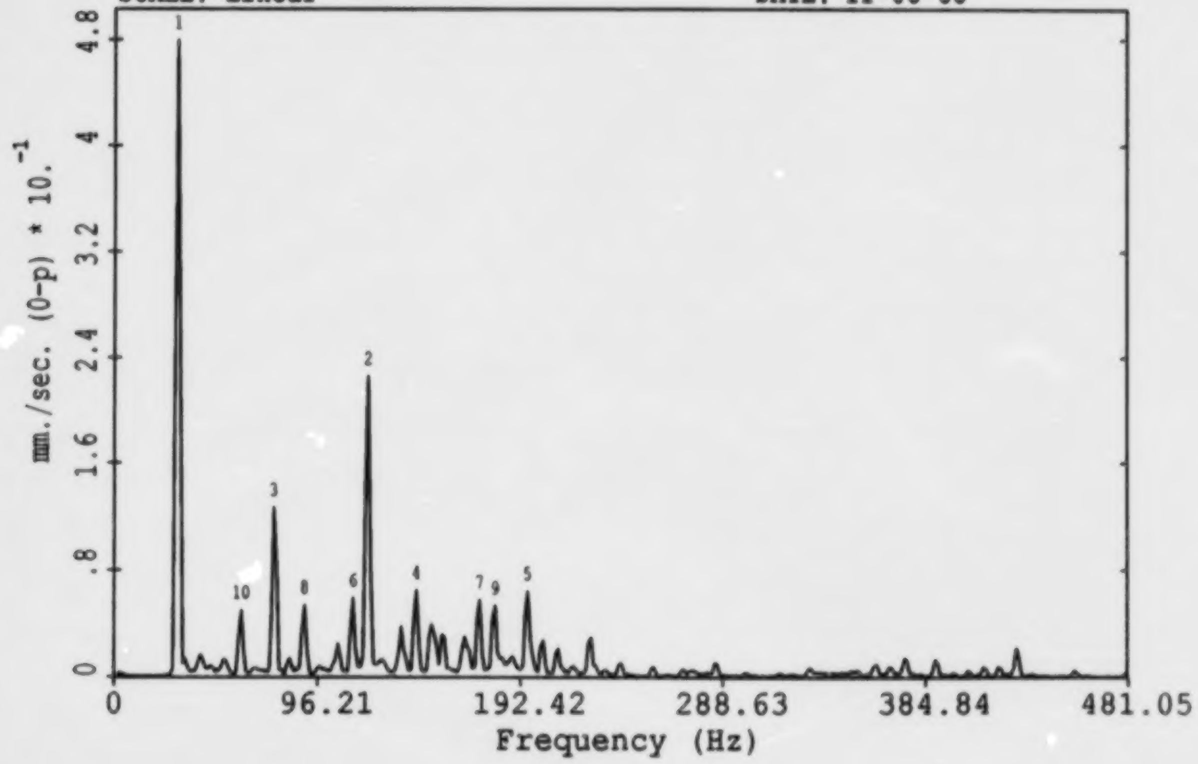


FIGURE B3

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator OB Brg Casing Vel. Vert.
PROCESS CONDITION : Load 3.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 0.49 |
| 2 | 120.3 | 0.31 |
| 3 | 75.8 | 0.14 |
| 4 | 180.4 | 0.07 |
| 5 | 173.2 | 0.07 |
| 6 | 113.0 | 0.05 |
| 7 | 196.0 | 0.04 |
| 8 | 90.2 | 0.04 |
| 9 | 151.5 | 0.03 |
| 10 | 143.1 | 0.03 |

SCALE: Linear DATE: 11-08-88

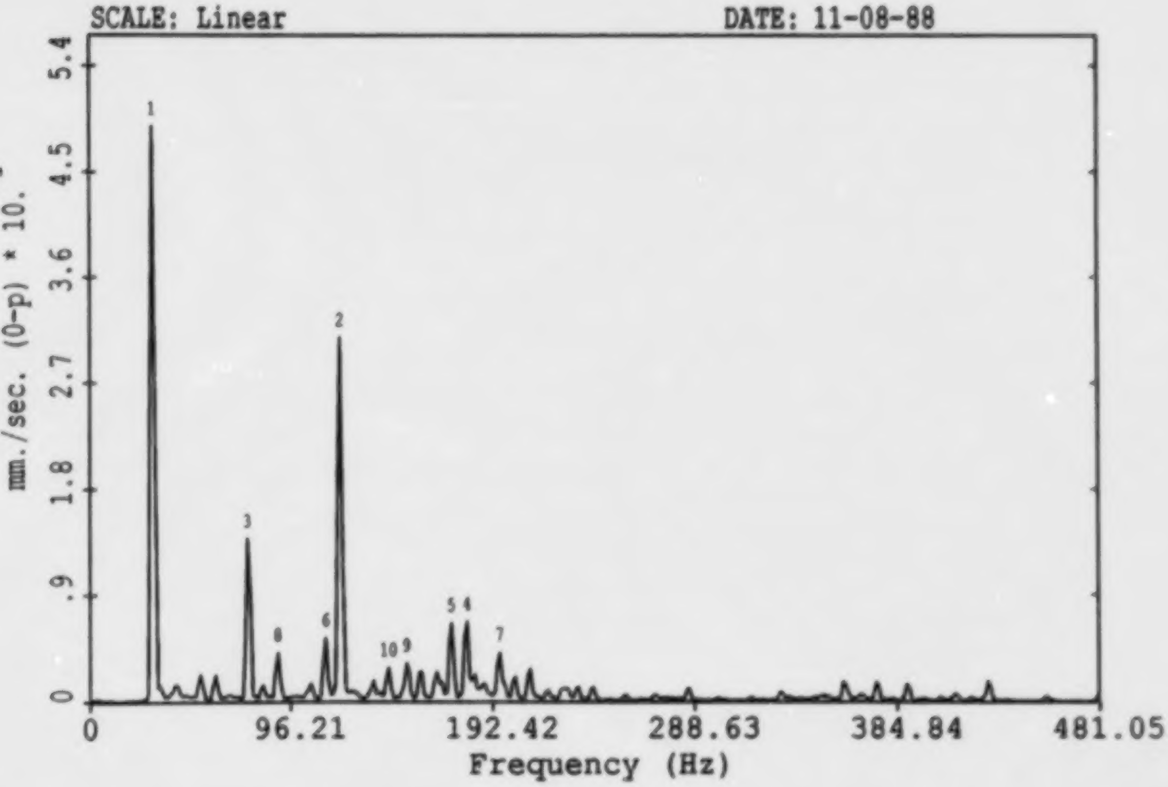
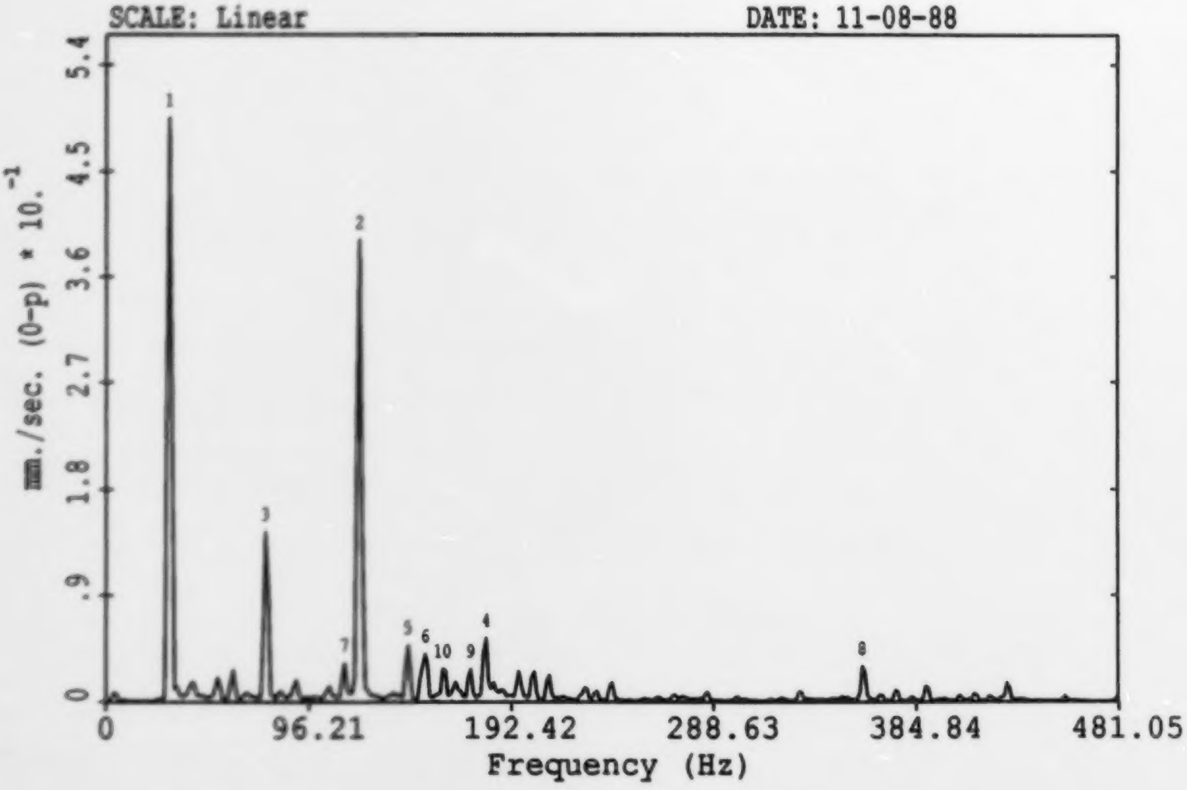


FIGURE B4

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator OB Brg Casing Vel. Vert.
PROCESS CONDITION : Load 4.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 0.50 |
| 2 | 120.3 | 0.39 |
| 3 | 75.8 | 0.14 |
| 4 | 180.4 | 0.05 |
| 5 | 143.1 | 0.05 |
| 6 | 151.5 | 0.04 |
| 7 | 113.0 | 0.03 |
| 8 | 359.6 | 0.03 |
| 9 | 173.2 | 0.03 |
| 10 | 160.0 | 0.03 |



SCALE: Linear

DATE: 11-08-88

FIGURE B5

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator OB Brg Casing Vel. Vert.
PROCESS CONDITION : Load 5.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 0.52 |
| 2 | 120.3 | 0.45 |
| 3 | 75.8 | 0.15 |
| 4 | 143.1 | 0.08 |
| 5 | 180.4 | 0.06 |
| 6 | 151.5 | 0.04 |
| 7 | 240.5 | 0.03 |
| 8 | 359.6 | 0.03 |
| 9 | 60.1 | 0.03 |
| 10 | 203.2 | 0.02 |

SCALE: Linear DATE: 11-08-88

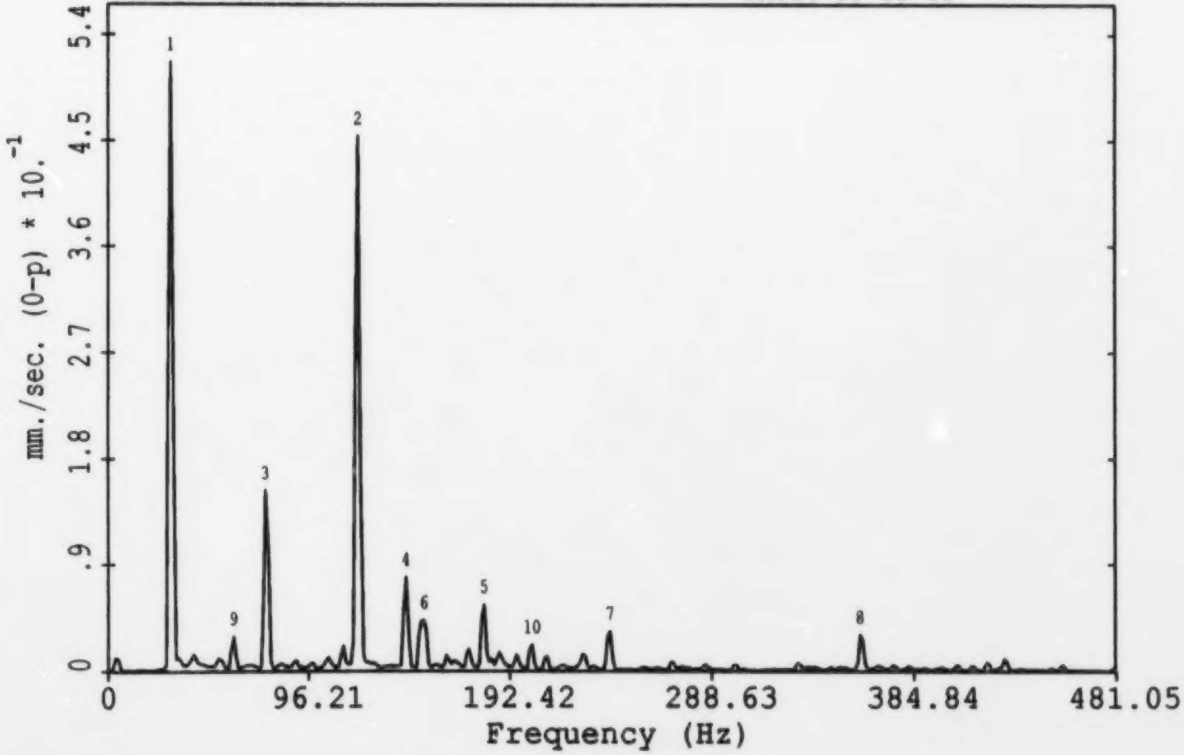


FIGURE B6

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator OB Brg Casing Vel. Vert.
PROCESS CONDITION : Load 6.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 0.53 |
| 2 | 120.3 | 0.43 |
| 3 | 75.8 | 0.16 |
| 4 | 143.1 | 0.11 |
| 5 | 180.4 | 0.06 |
| 6 | 150.3 | 0.05 |
| 7 | 167.2 | 0.04 |
| 8 | 60.1 | 0.03 |
| 9 | 173.2 | 0.02 |
| 10 | 359.6 | 0.02 |

SCALE: Linear DATE: 11-08-88

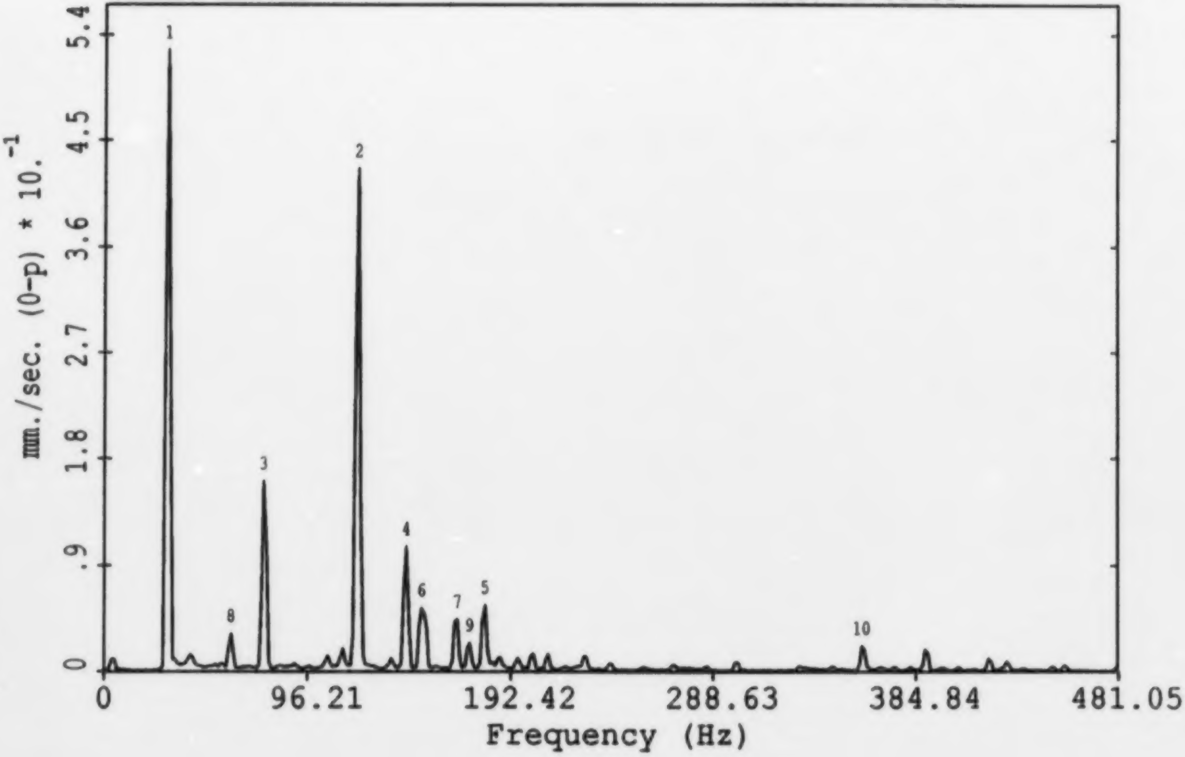


FIGURE B7

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator OB Brg Casing Vel. Vert.
PROCESS CONDITION : Load 6.9 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 0.53 |
| 2 | 120.3 | 0.39 |
| 3 | 75.8 | 0.17 |
| 4 | 170.8 | 0.11 |
| 5 | 143.1 | 0.11 |
| 6 | 150.3 | 0.06 |
| 7 | 60.1 | 0.04 |
| 8 | 389.7 | 0.03 |
| 9 | 240.5 | 0.03 |
| 10 | 359.6 | 0.02 |

SCALE: Linear DATE: 11-08-88

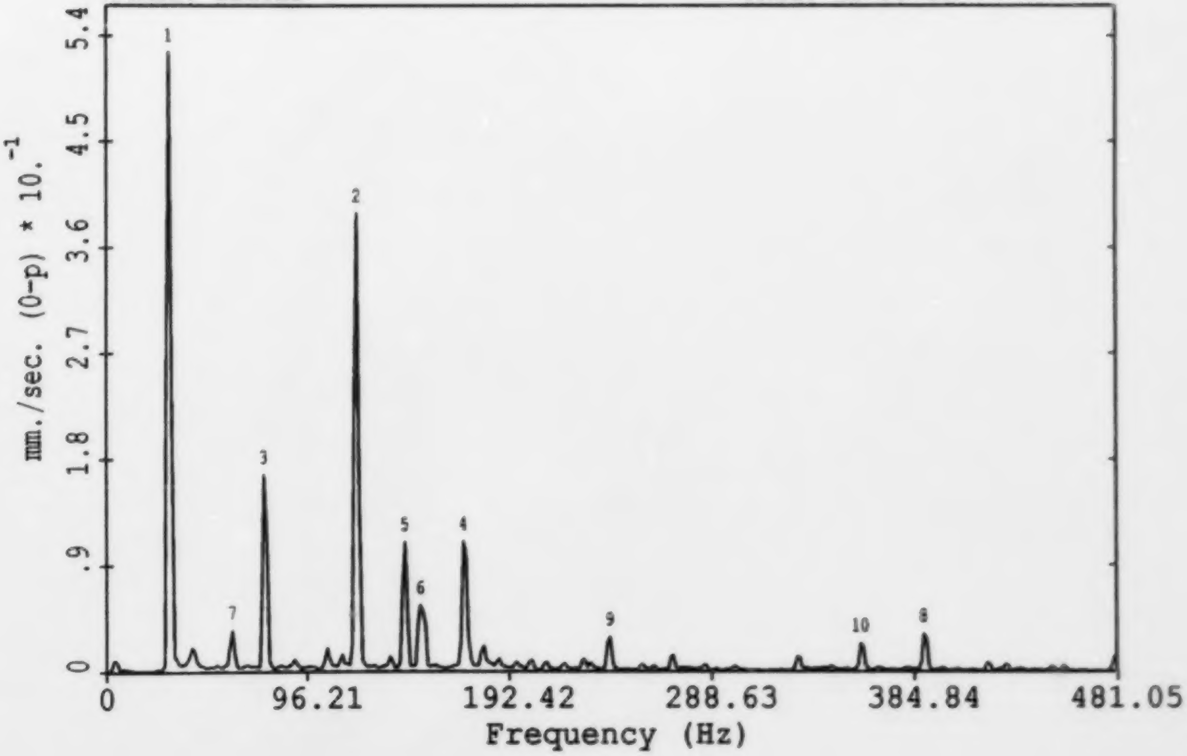


FIGURE B8

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator OB Brg Casing Vel. Hor.
PROCESS CONDITION : Load 0.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 2.80 |
| 2 | 60.1 | 0.24 |
| 3 | 120.3 | 0.20 |
| 4 | 75.8 | 0.16 |
| 5 | 143.1 | 0.12 |
| 6 | 149.1 | 0.08 |
| 7 | 90.2 | 0.07 |

SCALE: Linear

DATE: 11-08-88

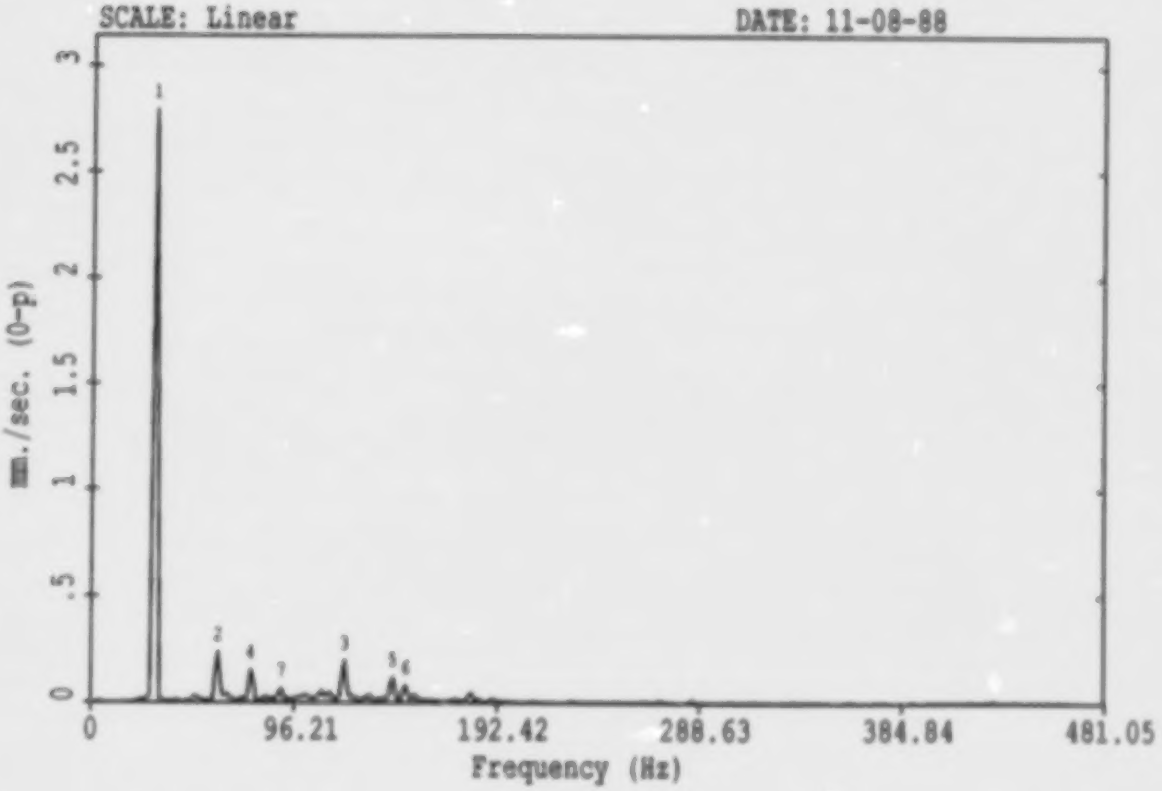


FIGURE B9

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator OB Brg Casing Vel. Hor.
PROCESS CONDITION : Load 1.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 2.71 |
| 2 | 25.3 | 0.46 |
| 3 | 60.1 | 0.35 |
| 4 | 50.5 | 0.30 |
| 5 | 120.3 | 0.25 |
| 6 | 75.8 | 0.16 |
| 7 | 110.6 | 0.15 |
| 8 | 143.1 | 0.15 |
| 9 | 95.0 | 0.12 |
| 10 | 105.8 | 0.12 |

SCALE: Linear

DATE: 11-08-86

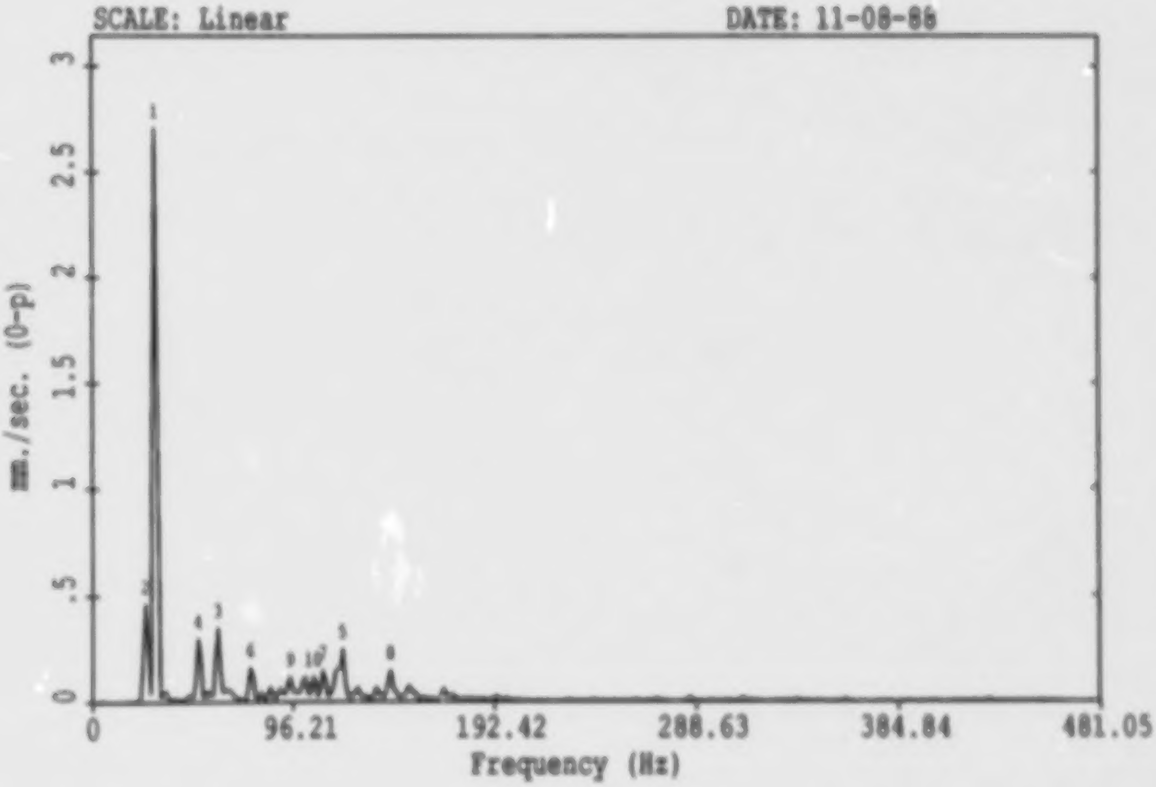


FIGURE B10

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator OB Brg Casing Vel. Hor.
PROCESS CONDITION : Load 2.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 2.94 |
| 2 | 120.3 | 0.38 |
| 3 | 60.1 | 0.30 |
| 4 | 75.8 | 0.25 |
| 5 | 143.1 | 0.22 |
| 6 | 155.1 | 0.07 |

SCALE: Linear DATE: 11-08-88

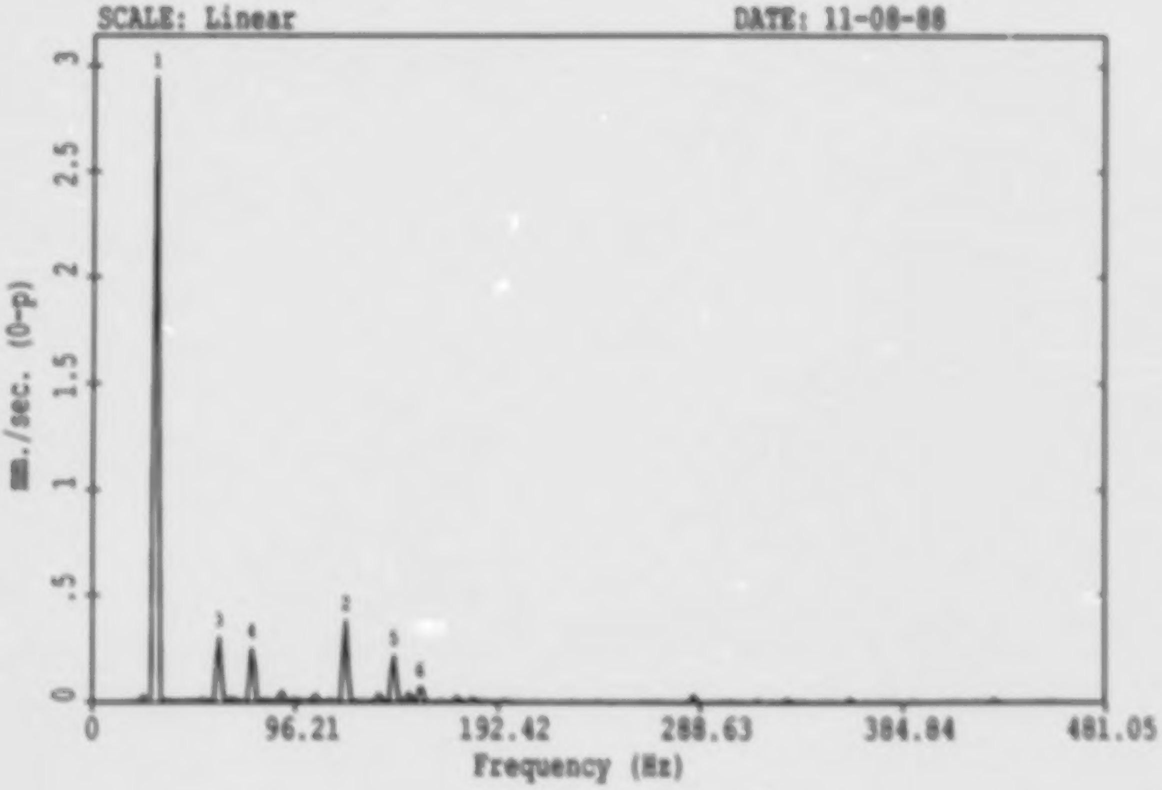


FIGURE B11

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator OB Brg Casing Vel. Hor.
PROCESS CONDITION : Load 3.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 2.51 |
| 2 | 120.3 | 0.40 |
| 3 | 60.1 | 0.34 |
| 4 | 75.8 | 0.29 |
| 5 | 143.1 | 0.20 |
| 6 | 158.7 | 0.09 |
| 7 | 90.2 | 0.08 |

SCALE: Linear

DATE: 11-08-88

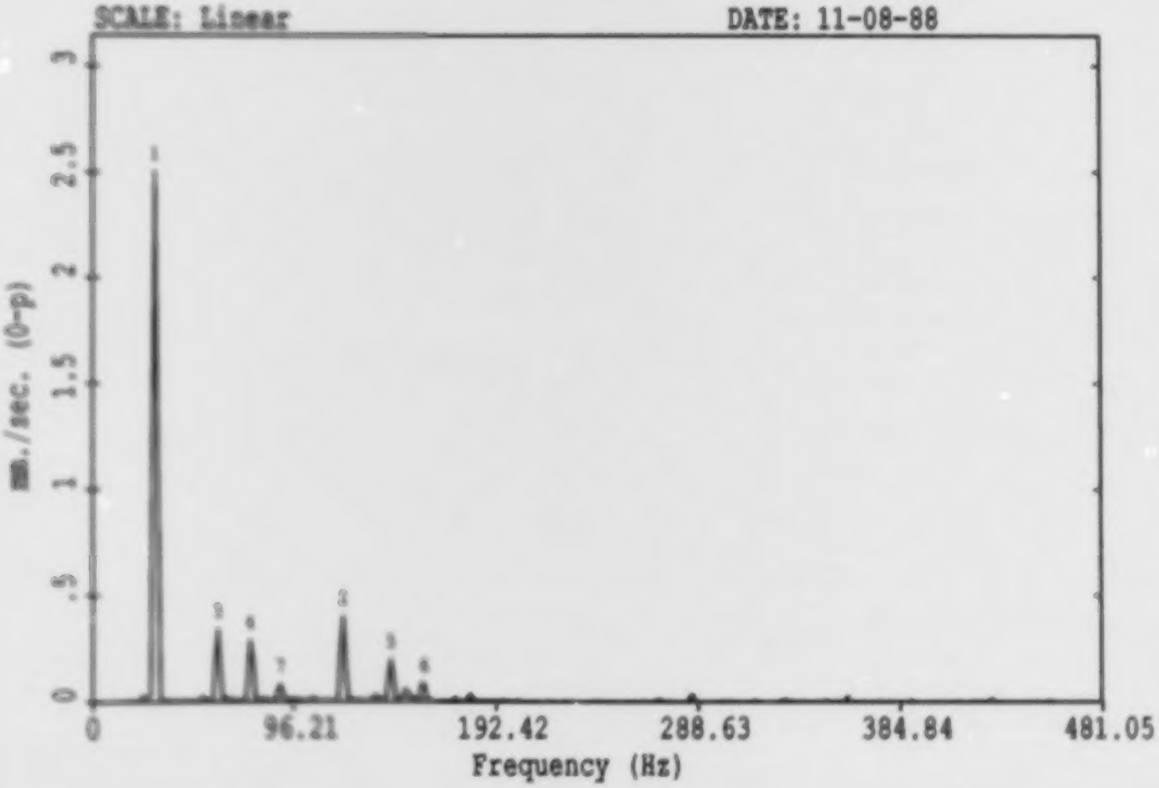


FIGURE B12

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator OB Brg Casing Vel. Hor.
PROCESS CONDITION : Load 4.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 2.32 |
| 2 | 120.3 | 0.46 |
| 3 | 75.8 | 0.31 |
| 4 | 60.1 | 0.26 |
| 5 | 143.1 | 0.17 |
| 6 | 160.0 | 0.06 |

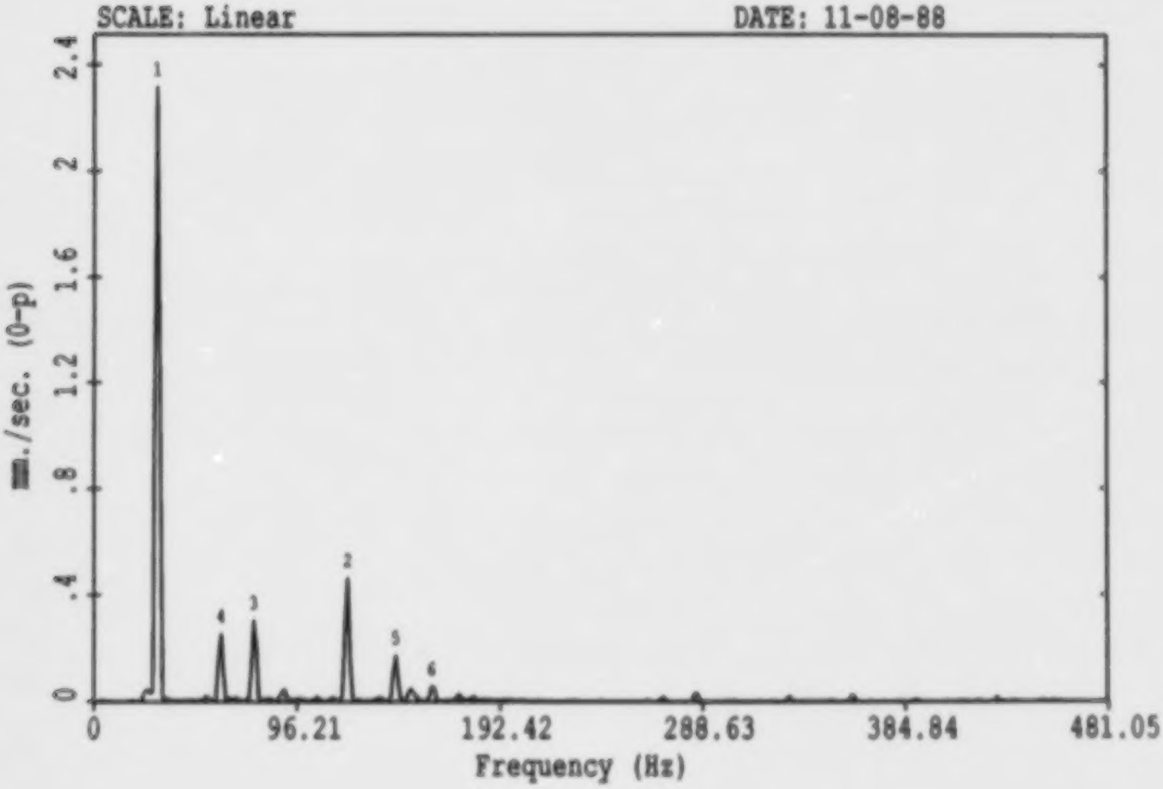


FIGURE B13

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator OB Brg Casing Vel. Hor.
PROCESS CONDITION : Load 5.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 2.36 |
| 2 | 120.3 | 0.47 |
| 3 | 75.8 | 0.30 |
| 4 | 60.1 | 0.21 |
| 5 | 143.1 | 0.16 |
| 6 | 162.4 | 0.06 |

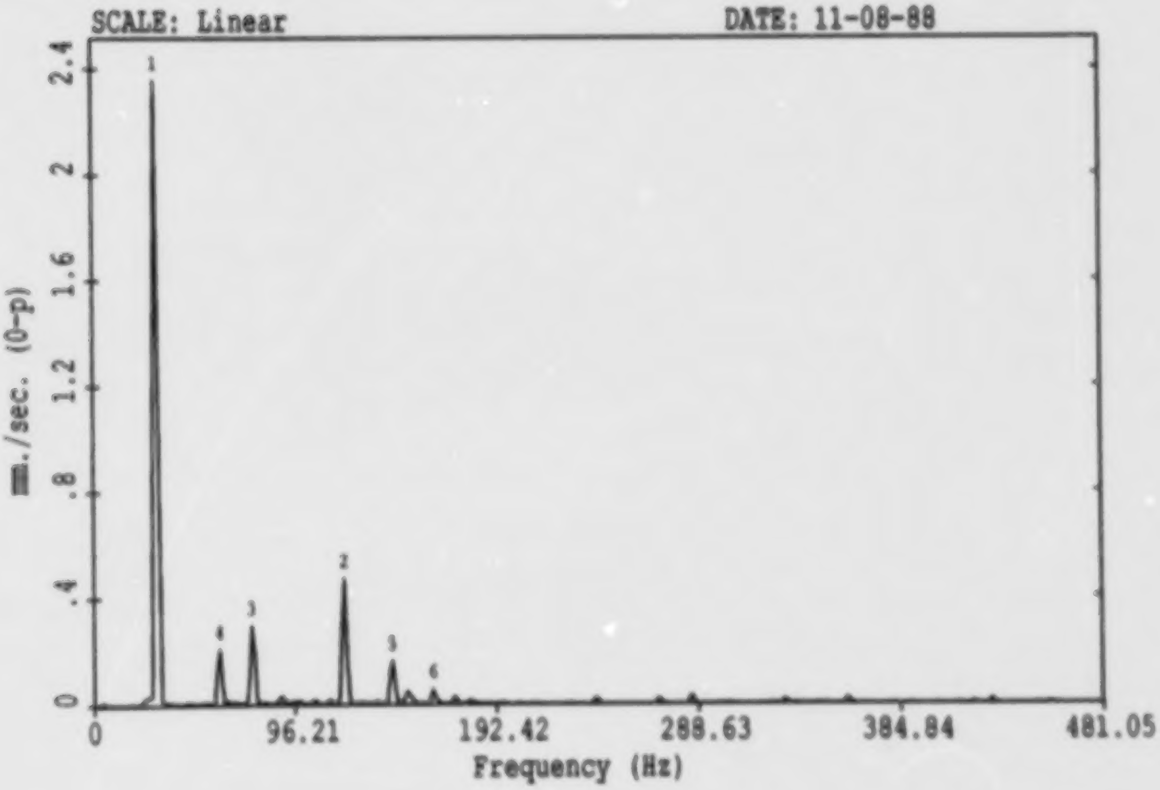
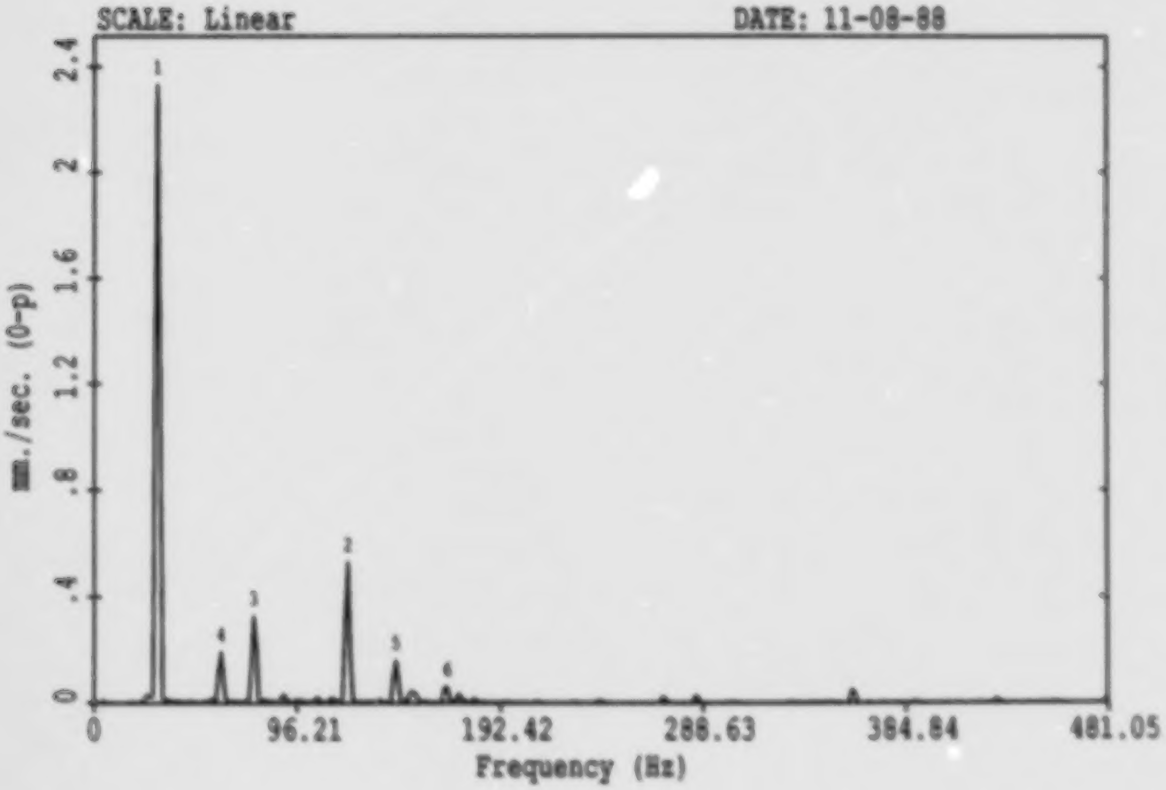


FIGURE B14

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator OB Brg Casing Vel. Hor.
PROCESS CONDITION : Load 6.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 2.33 |
| 2 | 120.3 | 0.53 |
| 3 | 75.8 | 0.33 |
| 4 | 60.1 | 0.19 |
| 5 | 143.1 | 0.16 |
| 6 | 167.2 | 0.06 |


SCALE: Linear

DATE: 11-08-88

FIGURE B15

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator OB Brg Casing Vel. Hor.
PROCESS CONDITION : Load 6.9 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 2.34 |
| 2 | 120.3 | 0.51 |
| 3 | 75.8 | 0.34 |
| 4 | 170.8 | 0.21 |
| 5 | 143.1 | 0.16 |
| 6 | 60.1 | 0.15 |
| 7 | 359.6 | 0.06 |

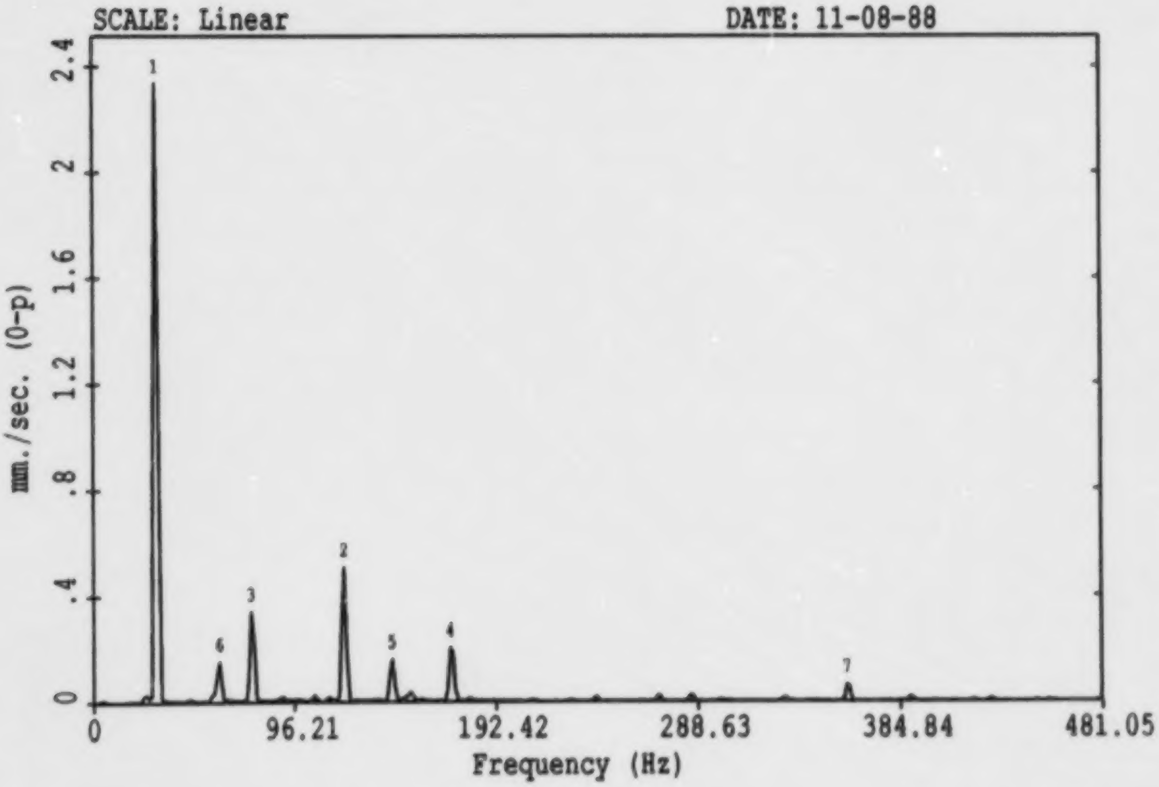


FIGURE B16

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator IB Brg Casing Vel. Vert.
PROCESS CONDITION : Load 0.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 120.3 | 0.26 |
| 2 | 60.1 | 0.25 |
| 3 | 30.1 | 0.14 |
| 4 | 113.0 | 0.13 |
| 5 | 105.8 | 0.07 |
| 6 | 75.8 | 0.07 |
| 7 | 102.2 | 0.06 |
| 8 | 285.0 | 0.06 |
| 9 | 143.1 | 0.05 |
| 10 | 149.1 | 0.05 |

SCALE: Linear

DATE: 11-08-88

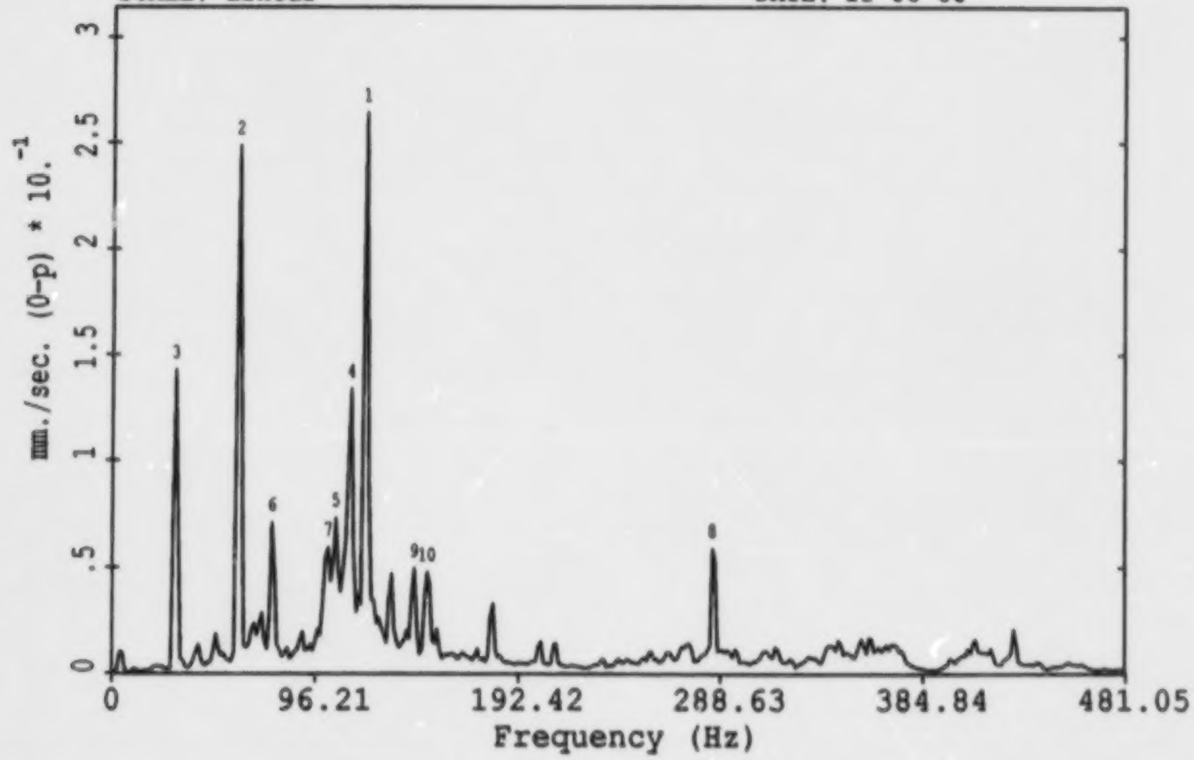


FIGURE B17

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator IB Brg Casing Vel. Vert.
PROCESS CONDITION : Load 1.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 50.5 | 0.27 |
| 2 | 120.3 | 0.27 |
| 3 | 60.1 | 0.26 |
| 4 | 110.6 | 0.23 |
| 5 | 105.8 | 0.22 |
| 6 | 115.5 | 0.12 |
| 7 | 30.1 | 0.11 |
| 8 | 25.3 | 0.09 |
| 9 | 102.2 | 0.09 |
| 10 | 143.1 | 0.09 |

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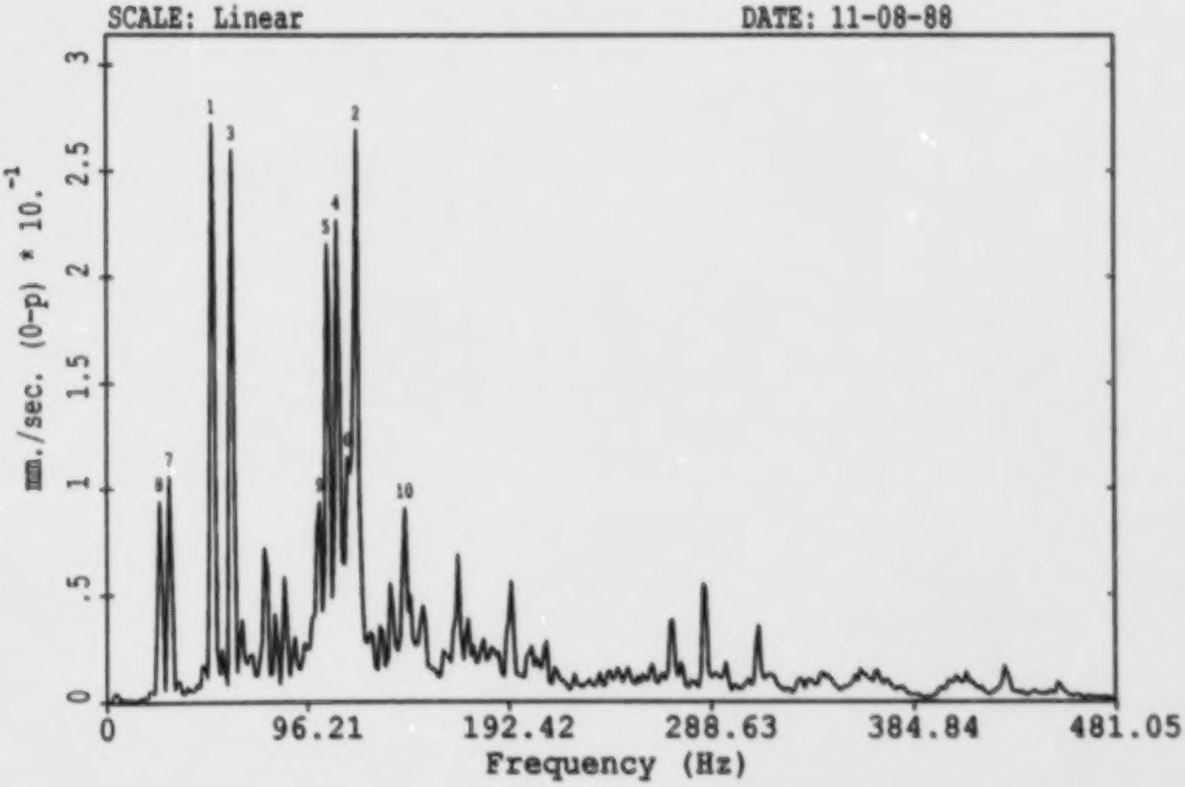


FIGURE B18

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator IB Brg Casing Vel. Vert.
PROCESS CONDITION : Load 2.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 120.3 | 0.33 |
| 2 | 30.1 | 0.21 |
| 3 | 60.1 | 0.14 |
| 4 | 196.0 | 0.10 |
| 5 | 90.2 | 0.10 |
| 6 | 113.0 | 0.09 |
| 7 | 75.8 | 0.08 |
| 8 | 143.1 | 0.08 |
| 9 | 173.2 | 0.08 |
| 10 | 315.1 | 0.06 |

SCALE: Linear DATE: 11-08-88

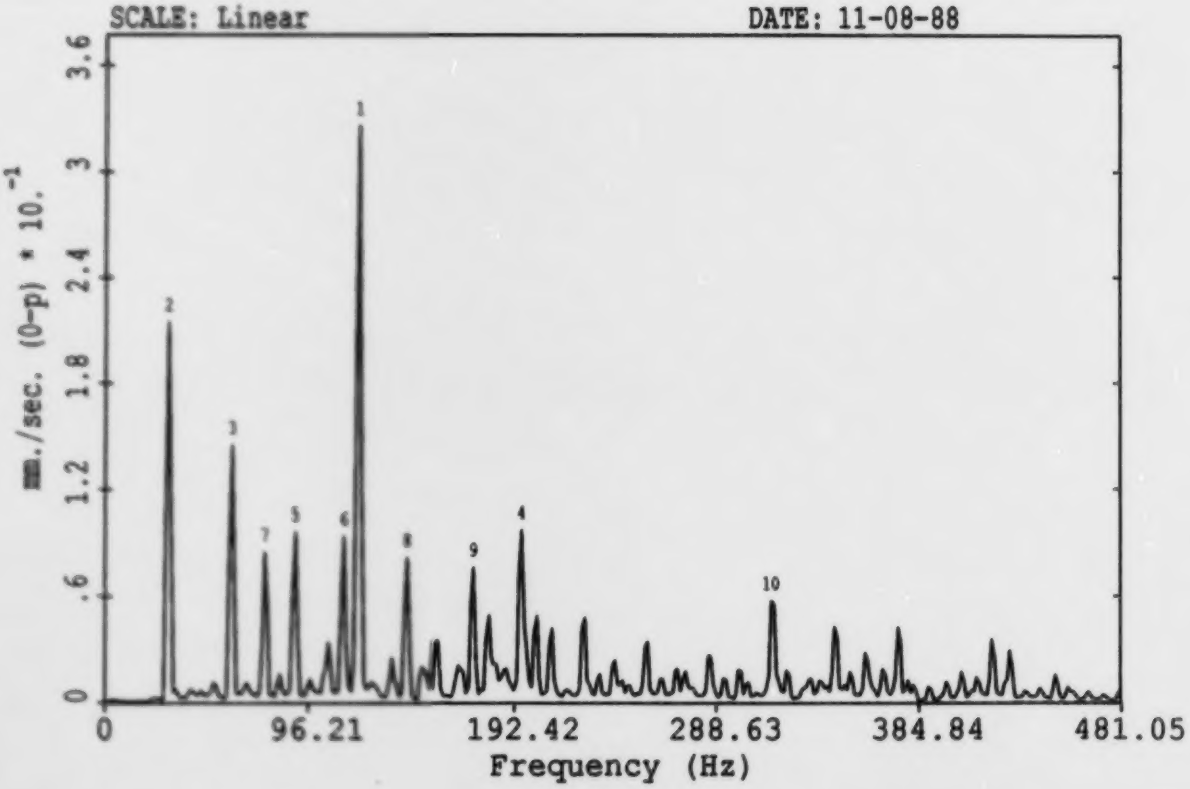


FIGURE B19

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator IB Brg Casing Vel. Vert.
PROCESS CONDITION : Load 3.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 120.3 | 0.43 |
| 2 | 30.1 | 0.22 |
| 3 | 60.1 | 0.09 |
| 4 | 75.8 | 0.09 |
| 5 | 113.0 | 0.09 |
| 6 | 180.4 | 0.08 |
| 7 | 173.2 | 0.07 |
| 8 | 90.2 | 0.07 |
| 9 | 143.1 | 0.07 |
| 10 | 240.5 | 0.06 |

SCALE: Linear DATE: 11-08-88

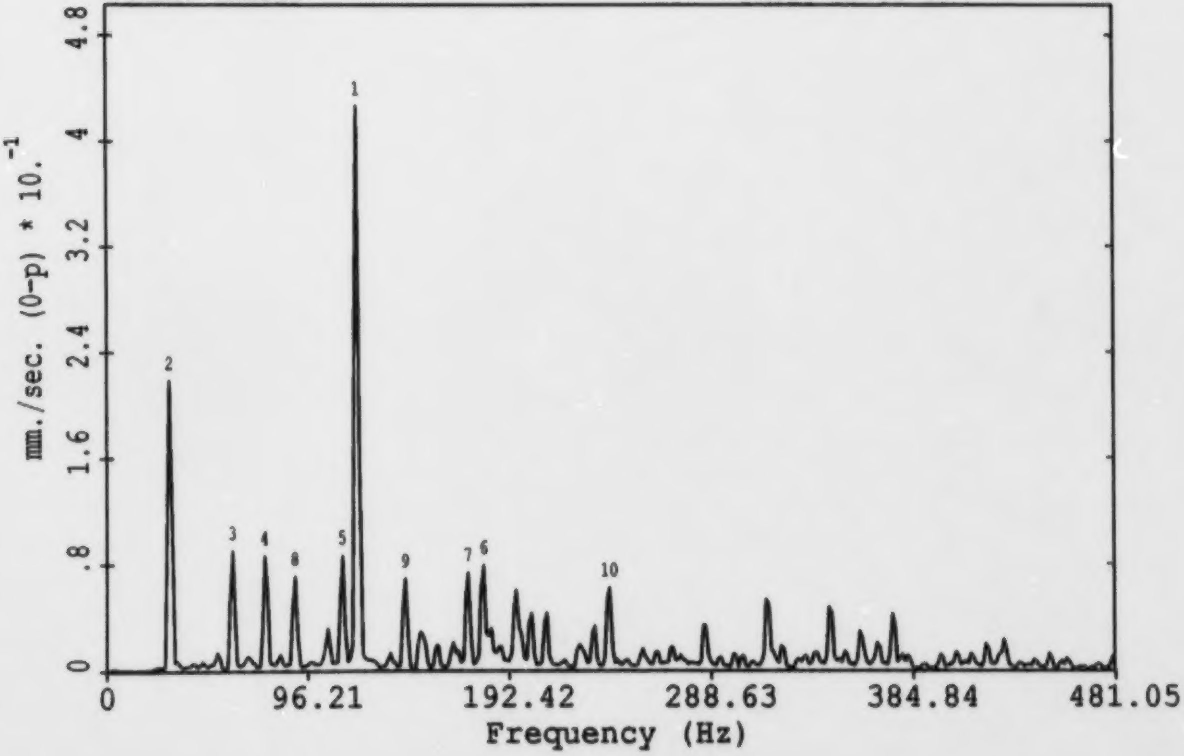


FIGURE B20

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator IB Brg Casing Vel. Vert.
PROCESS CONDITION : Load 4.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 120.3 | 0.52 |
| 2 | 30.1 | 0.27 |
| 3 | 75.8 | 0.09 |
| 4 | 240.5 | 0.07 |
| 5 | 143.1 | 0.06 |
| 6 | 60.1 | 0.05 |
| 7 | 113.0 | 0.05 |
| 8 | 203.2 | 0.05 |
| 9 | 150.3 | 0.04 |
| 10 | 286.2 | 0.04 |

SCALE: Linear

DATE: 11-08-88

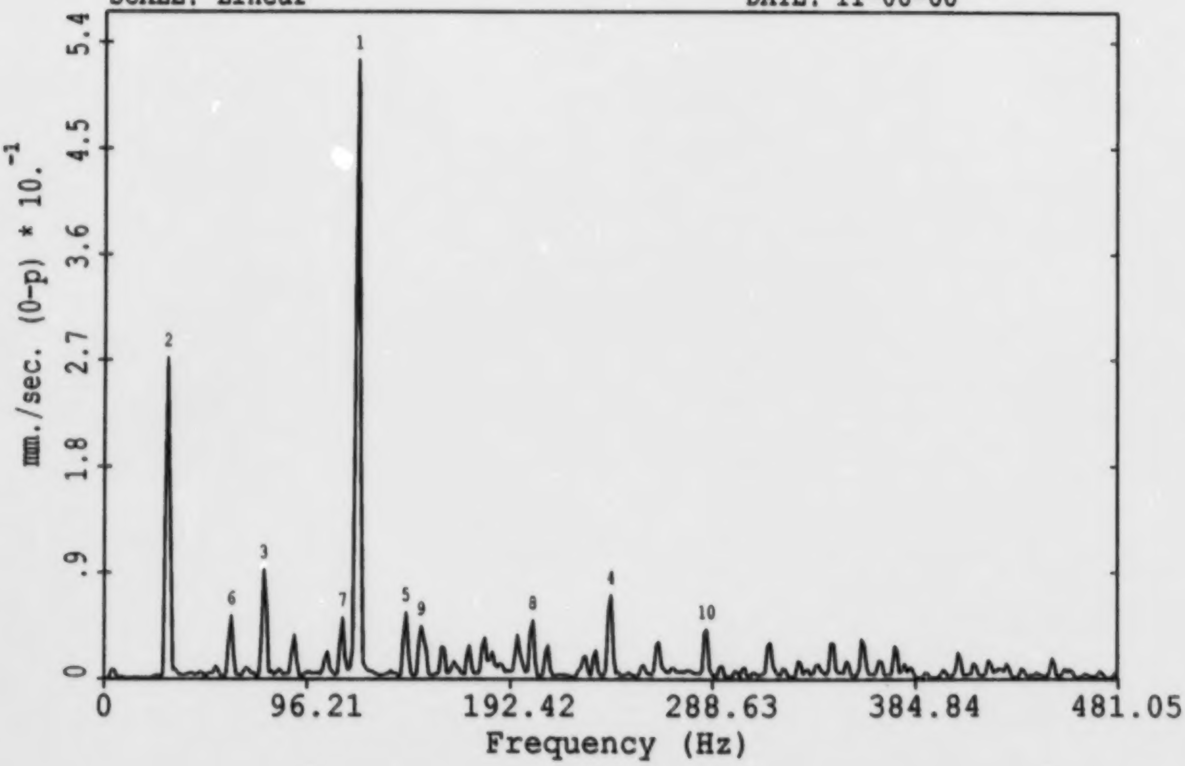


FIGURE B21

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator IB Brg Casing Vel. Vert.
PROCESS CONDITION : Load 5.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 120.3 | 0.59 |
| 2 | 30.1 | 0.35 |
| 3 | 75.8 | 0.10 |
| 4 | 240.5 | 0.06 |
| 5 | 143.1 | 0.06 |
| 6 | 180.4 | 0.05 |
| 7 | 60.1 | 0.05 |
| 8 | 286.2 | 0.05 |
| 9 | 150.3 | 0.05 |
| 10 | 203.2 | 0.04 |

SCALE: Linear

DATE: 11-08-88

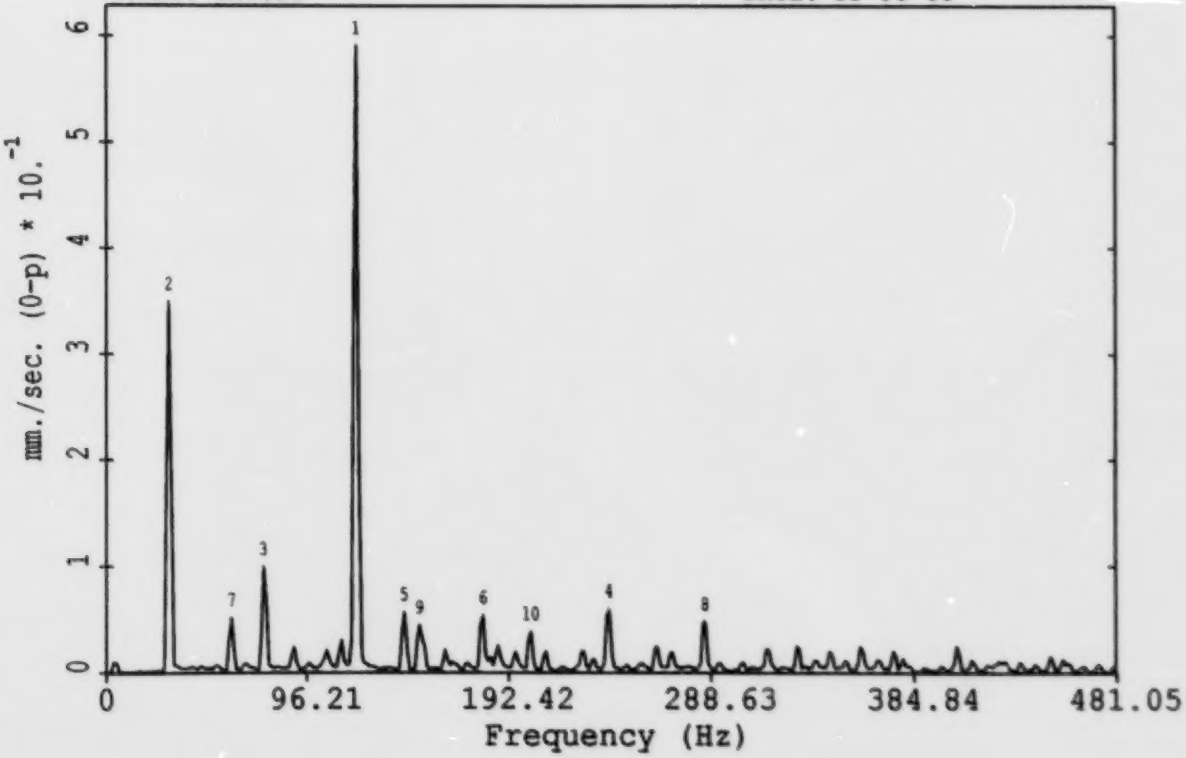


FIGURE B22

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator IB Brg Casing Vel. Vert.
PROCESS CONDITION : Load 6.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 120.3 | 0.57 |
| 2 | 30.1 | 0.40 |
| 3 | 75.8 | 0.10 |
| 4 | 240.5 | 0.07 |
| 5 | 143.1 | 0.06 |
| 6 | 60.1 | 0.05 |
| 7 | 180.4 | 0.05 |
| 8 | 150.3 | 0.05 |
| 9 | 286.2 | 0.05 |
| 10 | 167.2 | 0.04 |

SCALE: Linear DATE: 11-08-88

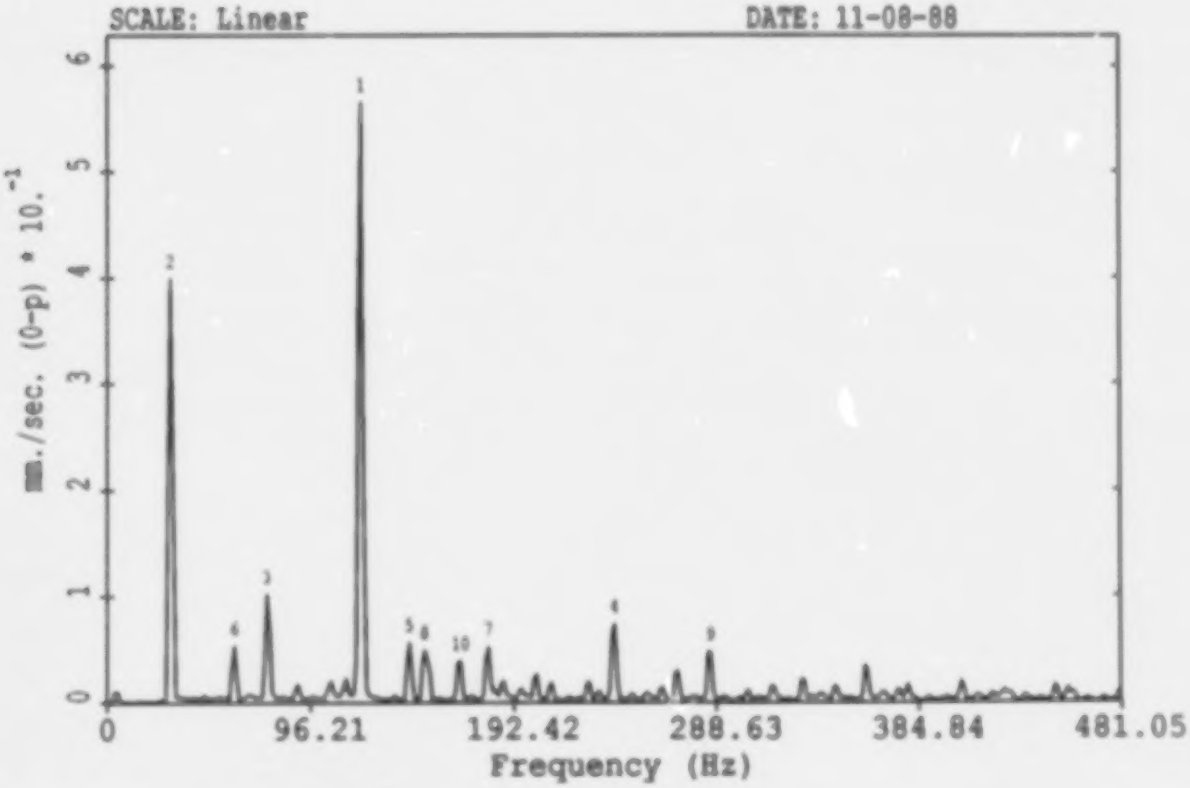


FIGURE B23

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator IB Brg Casing Vel. Vert.
PROCESS CONDITION : Load 6.9 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 120.3 | 0.53 |
| 2 | 30.1 | 0.45 |
| 3 | 75.8 | 0.11 |
| 4 | 240.5 | 0.10 |
| 5 | 170.8 | 0.09 |
| 6 | 60.1 | 0.05 |
| 7 | 286.2 | 0.05 |
| 8 | 143.1 | 0.05 |
| 9 | 150.3 | 0.05 |
| 10 | 359.6 | 0.04 |

SCALE: Linear

DATE: 11-08-88

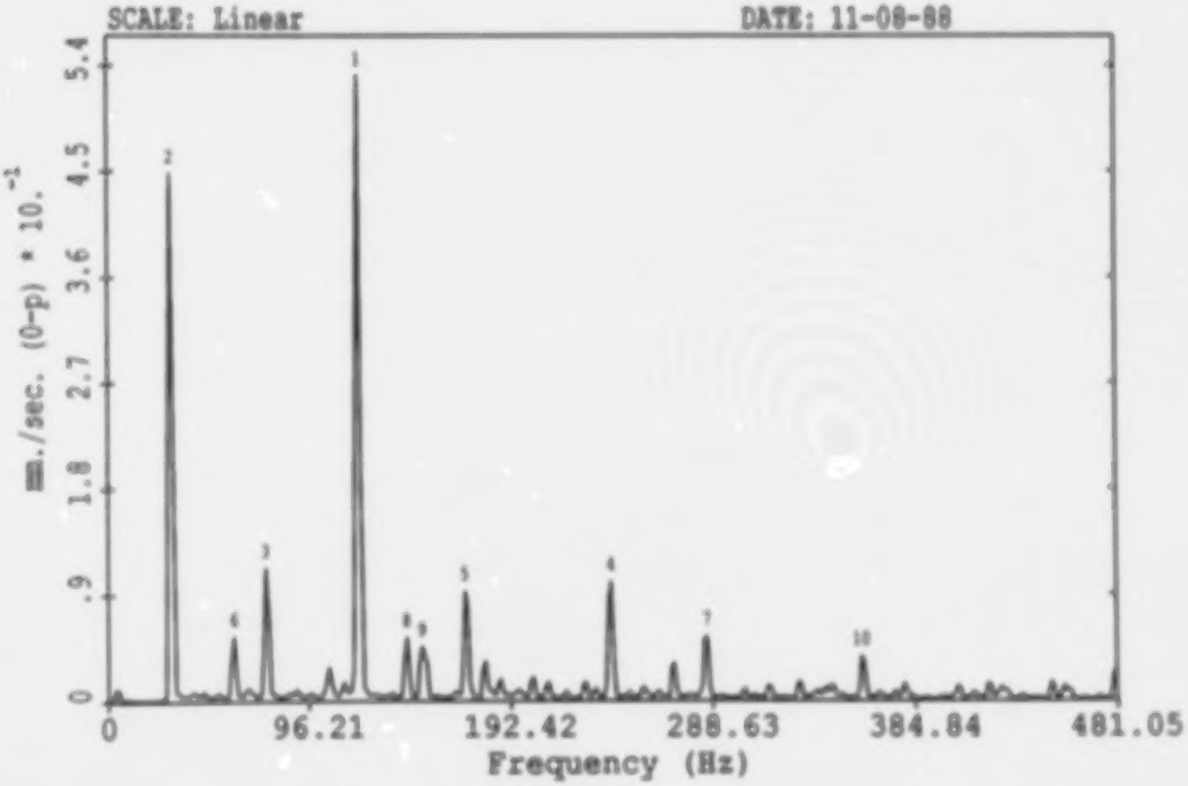


FIGURE B24

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator IB Brg Casing Vel. Hor.
PROCESS CONDITION : Load 0.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 1.94 |
| 2 | 75.8 | 0.29 |
| 3 | 90.2 | 0.27 |
| 4 | 120.3 | 0.18 |
| 5 | 143.1 | 0.15 |
| 6 | 60.1 | 0.10 |
| 7 | 180.4 | 0.10 |
| 8 | 149.1 | 0.09 |
| 9 | 93.8 | 0.07 |
| 10 | 109.4 | 0.06 |

SCALE: Linear

DATE: 11-08-88

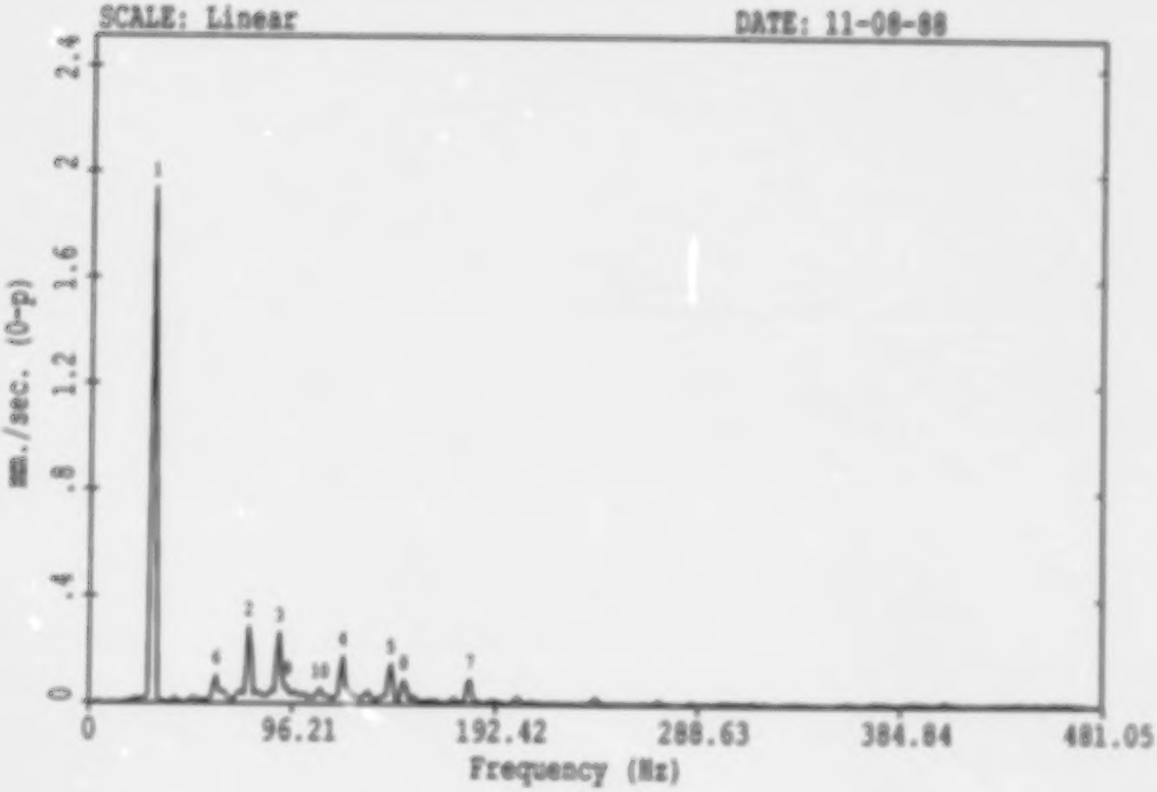


FIGURE B25

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator IB Brg Casing Vel. Hor.
PROCESS CONDITION : Load 1.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 1.76 |
| 2 | 25.3 | 0.81 |
| 3 | 120.3 | 0.34 |
| 4 | 50.5 | 0.26 |
| 5 | 75.8 | 0.24 |
| 6 | 60.1 | 0.23 |
| 7 | 95.0 | 0.22 |
| 8 | 80.6 | 0.19 |
| 9 | 90.2 | 0.16 |
| 10 | 143.1 | 0.14 |

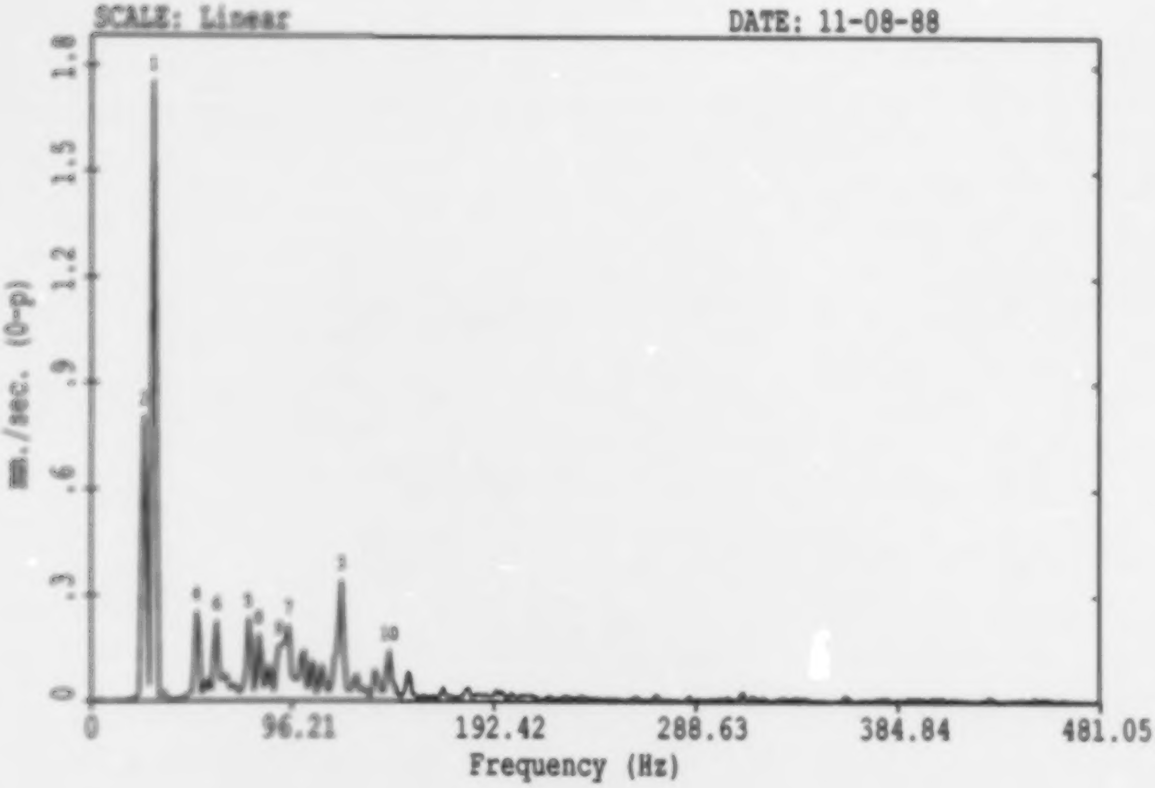


FIGURE B26

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator IB Brg Casing Vel. Hor.
PROCESS CONDITION : Load 2.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 1.59 |
| 2 | 60.1 | 0.43 |
| 3 | 120.3 | 0.40 |
| 4 | 143.1 | 0.28 |
| 5 | 75.8 | 0.27 |
| 6 | 155.1 | 0.08 |
| 7 | 90.2 | 0.08 |
| 8 | 150.3 | 0.07 |
| 9 | 135.9 | 0.06 |
| 10 | 285.0 | 0.05 |

SCALE: Linear DATE: 11-08-88

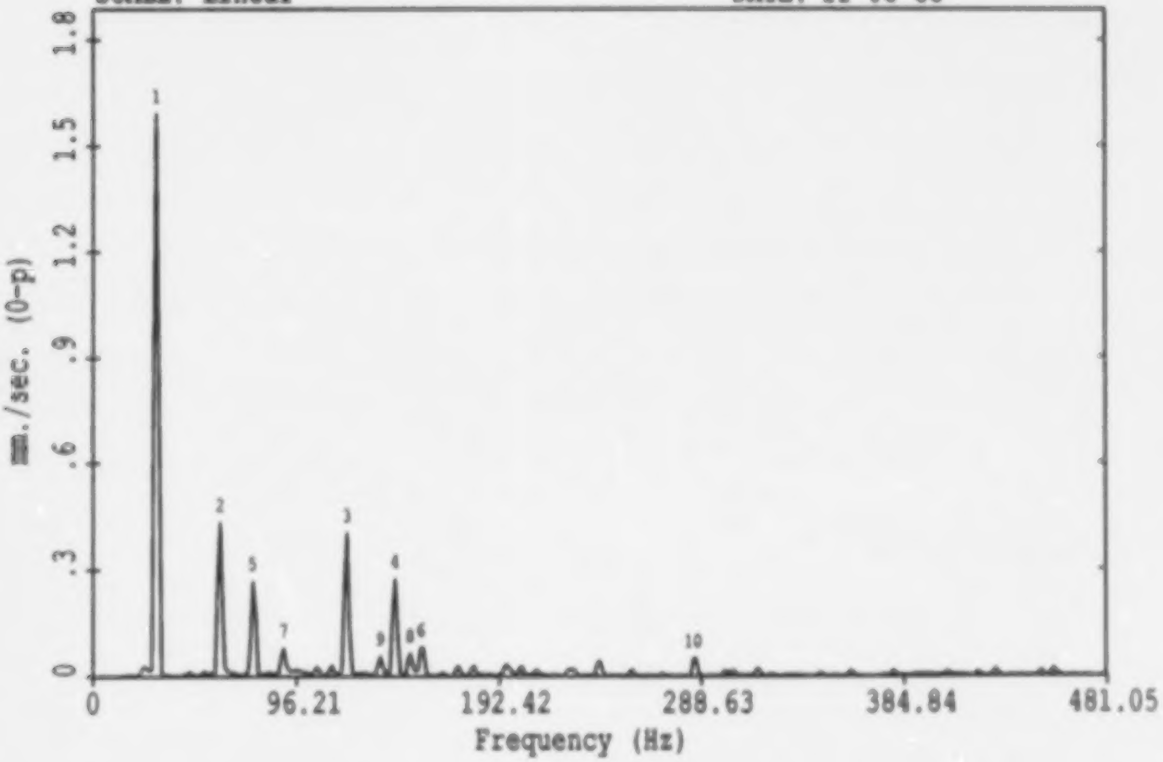


FIGURE B27

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator IB Brg Casing Vel. Hor.
PROCESS CONDITION : Load 3.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 1.26 |
| 2 | 60.1 | 0.48 |
| 3 | 120.3 | 0.47 |
| 4 | 143.1 | 0.30 |
| 5 | 75.8 | 0.29 |
| 6 | 158.7 | 0.09 |
| 7 | 90.2 | 0.08 |
| 8 | 150.3 | 0.07 |
| 9 | 285.0 | 0.06 |
| 10 | 180.4 | 0.05 |

SCALE: Linear DATE: 11-08-88

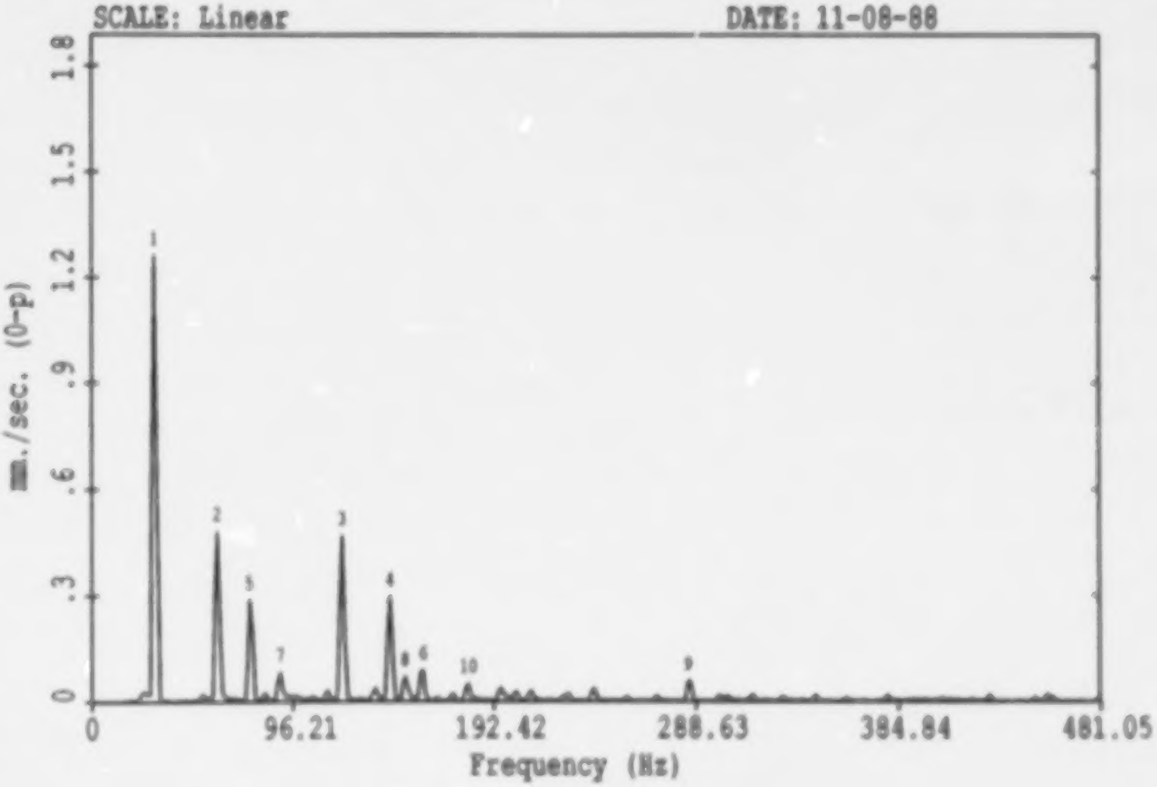


FIGURE B28

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator IB Brg Casing Vel. Hor.
PROCESS CONDITION : Load 4.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 1.11 |
| 2 | 120.3 | 0.58 |
| 3 | 60.1 | 0.37 |
| 4 | 75.8 | 0.30 |
| 5 | 143.1 | 0.30 |
| 6 | 150.3 | 0.07 |
| 7 | 160.0 | 0.06 |
| 8 | 90.2 | 0.06 |
| 9 | 286.2 | 0.05 |
| 10 | 25.3 | 0.05 |

SCALE: Linear

DATE: 11-08-88

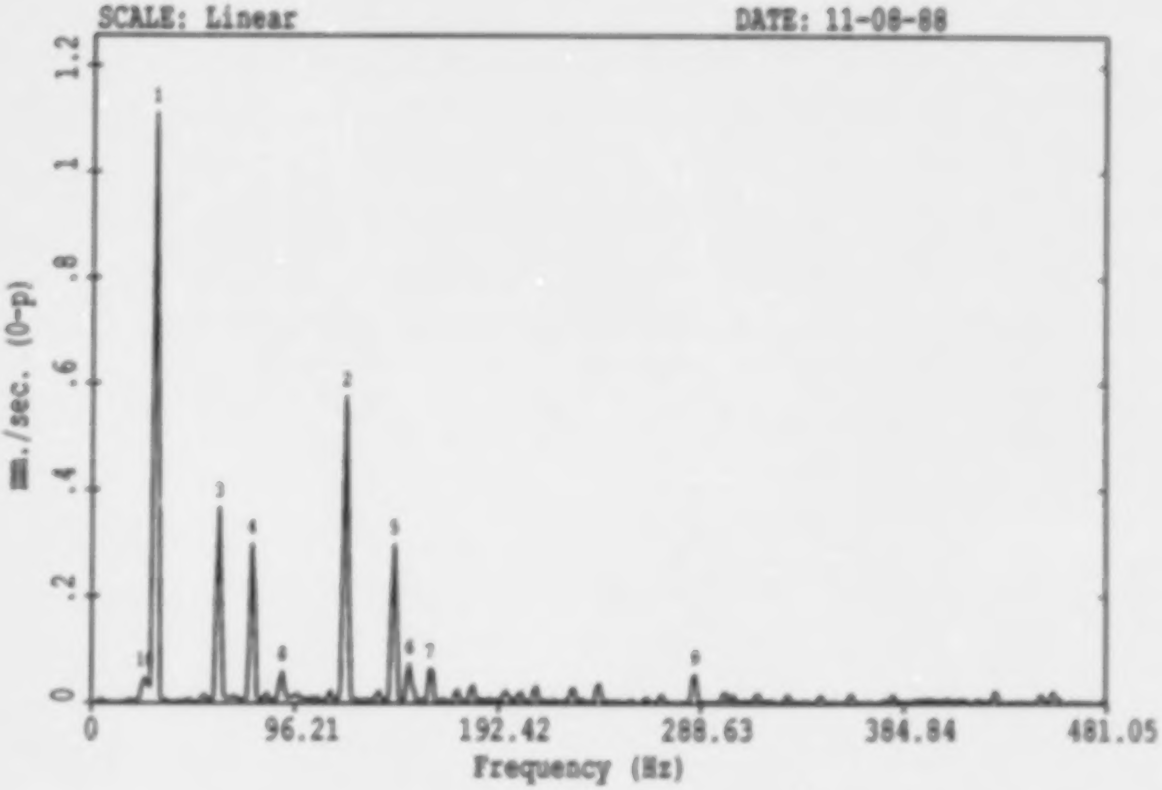


FIGURE B29

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator IB Brg Casing Vel. Hor.
PROCESS CONDITION : Load 5.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 1.17 |
| 2 | 120.3 | 0.61 |
| 3 | 60.1 | 0.31 |
| 4 | 75.8 | 0.30 |
| 5 | 143.1 | 0.29 |
| 6 | 240.5 | 0.08 |
| 7 | 150.3 | 0.07 |
| 8 | 90.2 | 0.07 |
| 9 | 162.4 | 0.06 |
| 10 | 286.2 | 0.05 |

SCALE: Linear

DATE: 11-08-88

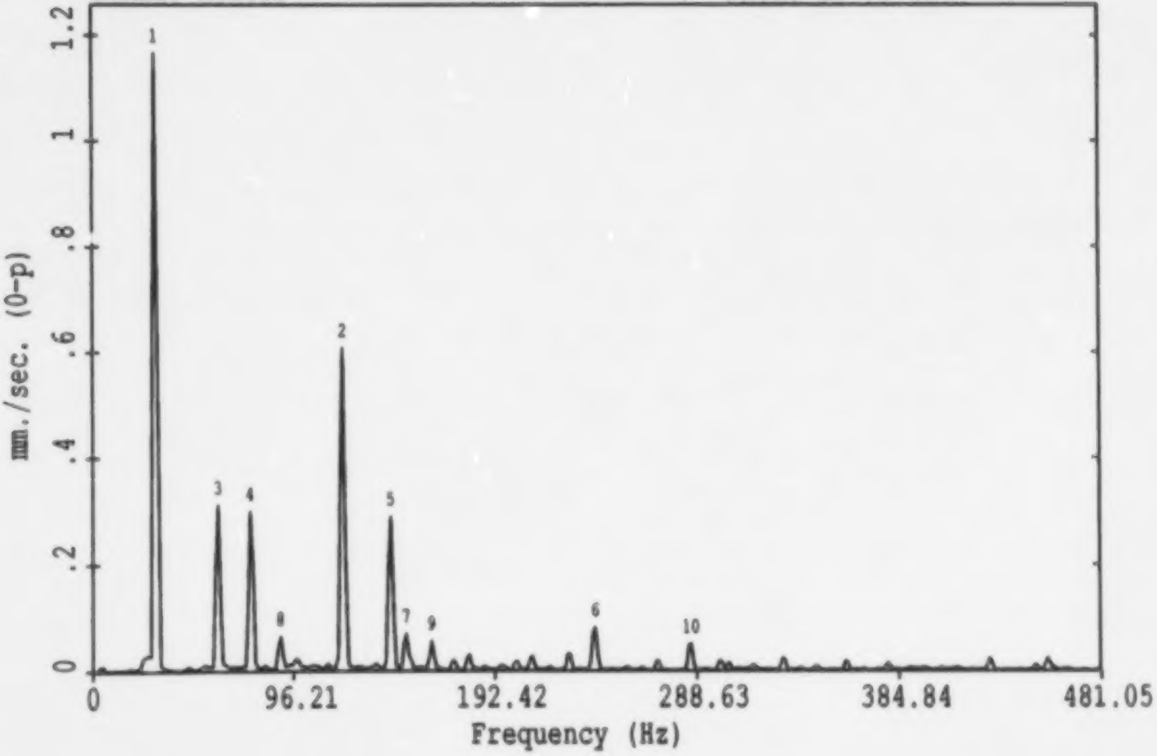


FIGURE B30

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator IB Brg Casing Vel. Hor.
PROCESS CONDITION : Load 6.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 1.20 |
| 2 | 120.3 | 0.69 |
| 3 | 75.8 | 0.33 |
| 4 | 143.1 | 0.29 |
| 5 | 60.1 | 0.27 |
| 6 | 90.2 | 0.07 |
| 7 | 150.3 | 0.07 |
| 8 | 167.2 | 0.06 |
| 9 | 286.2 | 0.05 |

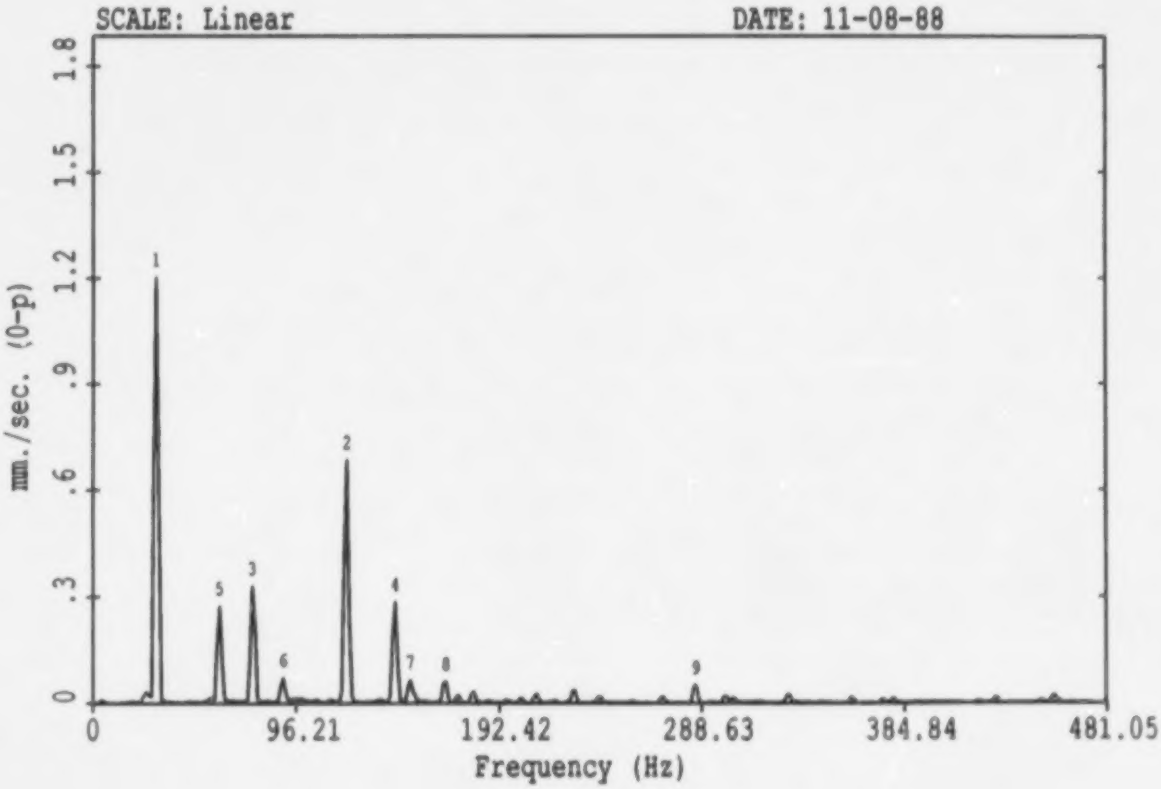


FIGURE B31

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator IB Brg Casing Vel. Hor.
PROCESS CONDITION : Load 6.9 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 1.27 |
| 2 | 120.3 | 0.71 |
| 3 | 75.8 | 0.38 |
| 4 | 143.1 | 0.28 |
| 5 | 60.1 | 0.22 |
| 6 | 170.8 | 0.07 |
| 7 | 240.5 | 0.07 |
| 8 | 150.3 | 0.06 |
| 9 | 286.2 | 0.05 |
| 10 | 90.2 | 0.05 |

SCALE: Linear

DATE: 11-08-88

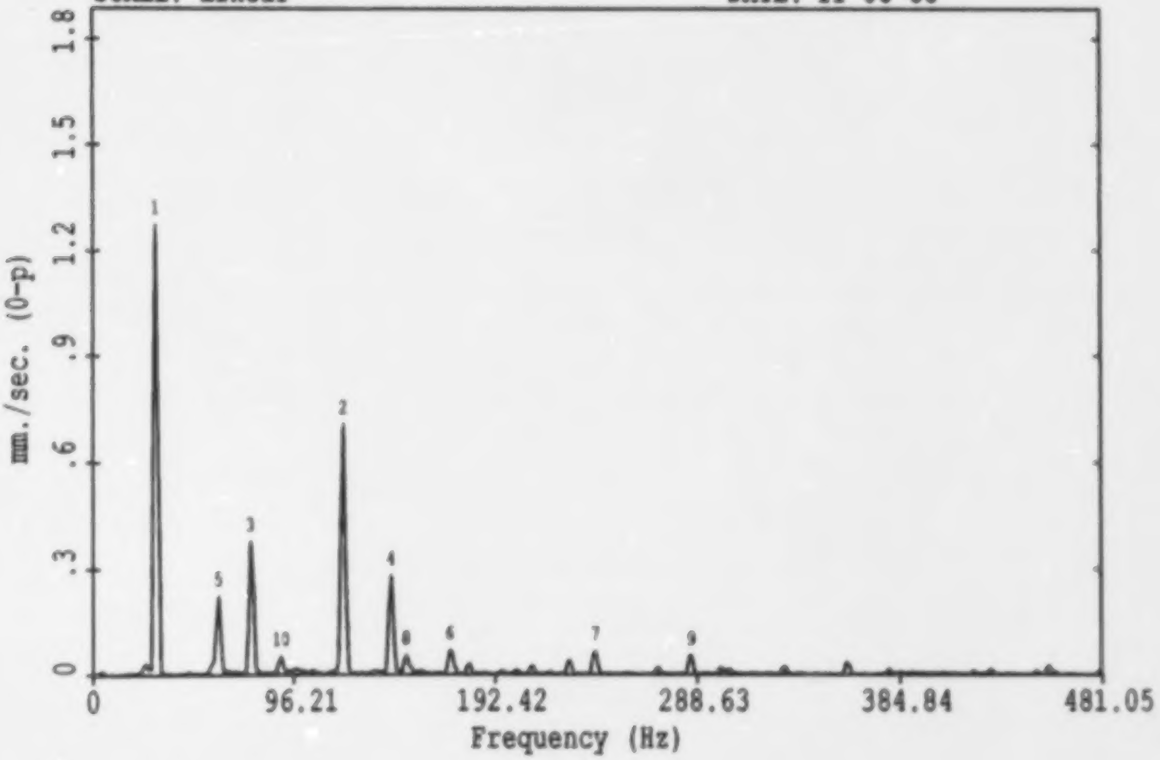


FIGURE B32

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator IB Casing Velocity Axial
PROCESS CONDITION : Load 0.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 0.23 |
| 2 | 60.1 | 0.21 |
| 3 | 67.3 | 0.18 |
| 4 | 71.0 | 0.14 |
| 5 | 90.2 | 0.12 |
| 6 | 75.8 | 0.09 |
| 7 | 286.2 | 0.06 |
| 8 | 122.7 | 0.05 |
| 9 | 125.1 | 0.05 |
| 10 | 210.5 | 0.04 |

SCALE: Linear

DATE: 08-11-88

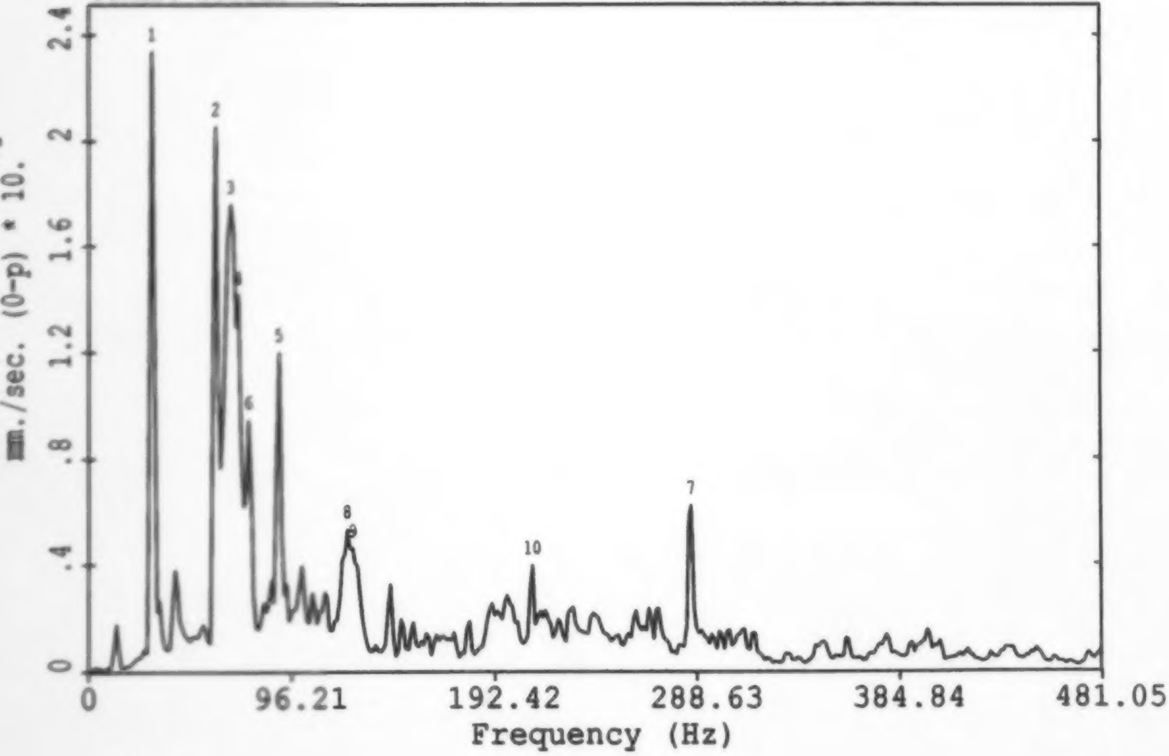


FIGURE B33

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator IB Casing Velocity Axial
PROCESS CONDITION : Load 1.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 0.29 |
| 2 | 60.1 | 0.27 |
| 3 | 75.8 | 0.25 |
| 4 | 168.4 | 0.18 |
| 5 | 68.6 | 0.17 |
| 6 | 90.2 | 0.16 |
| 7 | 25.3 | 0.14 |
| 8 | 64.9 | 0.12 |
| 9 | 286.2 | 0.10 |
| 10 | 80.6 | 0.10 |

SCALE: Linear DATE: 08-11-88

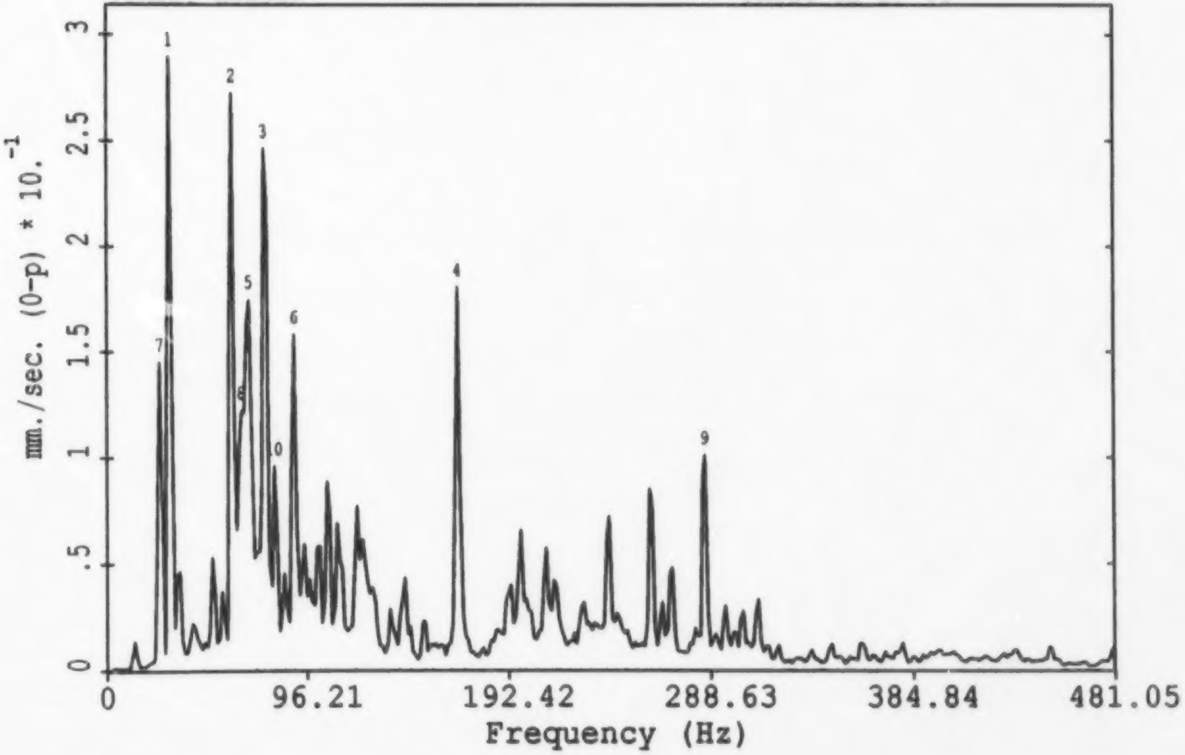
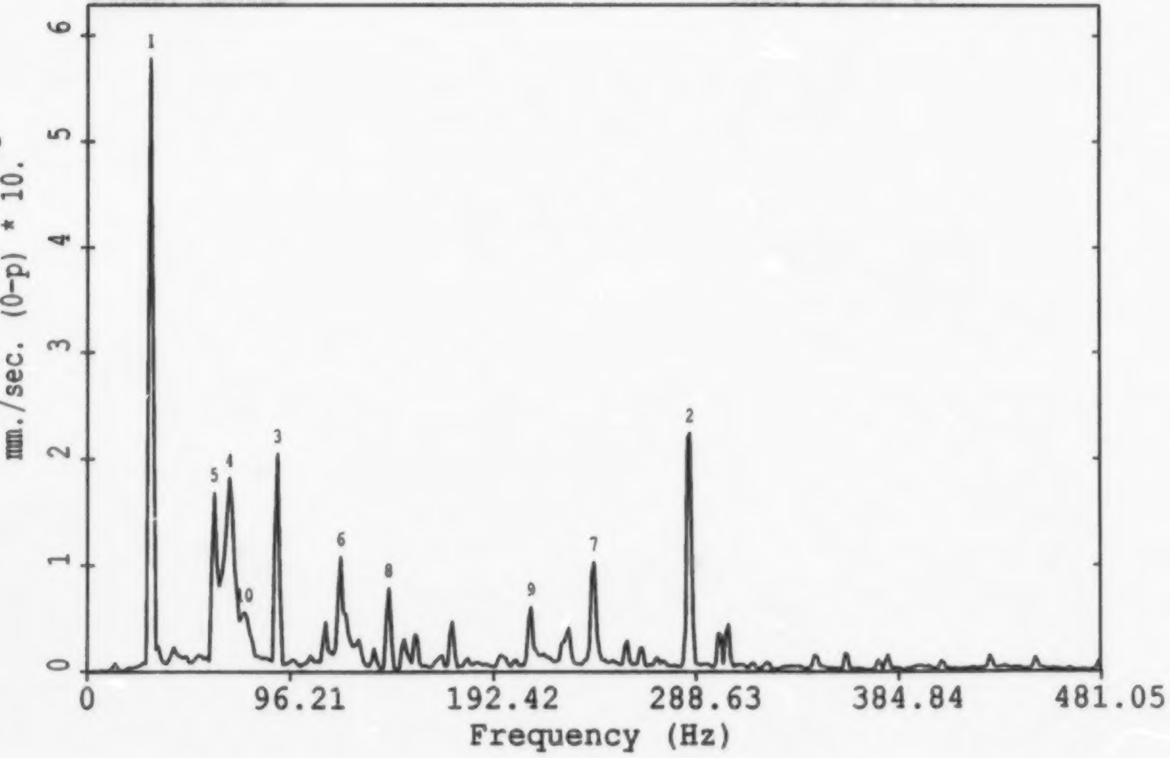


FIGURE B34

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator IB Casing Velocity Axial
PROCESS CONDITION : Load 2.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 0.58 |
| 2 | 286.2 | 0.22 |
| 3 | 90.2 | 0.20 |
| 4 | 67.3 | 0.18 |
| 5 | 60.1 | 0.17 |
| 6 | 120.3 | 0.11 |
| 7 | 240.5 | 0.10 |
| 8 | 143.1 | 0.08 |
| 9 | 210.5 | 0.06 |
| 10 | 74.6 | 0.06 |



SCALE: Linear

DATE: 08-11-88

FIGURE B35

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator IB Casing Velocity Axial
PROCESS CONDITION : Load 3.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 0.60 |
| 2 | 286.2 | 0.22 |
| 3 | 90.2 | 0.21 |
| 4 | 60.1 | 0.16 |
| 5 | 120.3 | 0.16 |
| 6 | 67.3 | 0.14 |
| 7 | 210.5 | 0.09 |
| 8 | 240.5 | 0.08 |
| 9 | 143.1 | 0.08 |
| 10 | 75.8 | 0.07 |

SCALE: Linear DATE: 08-11-88

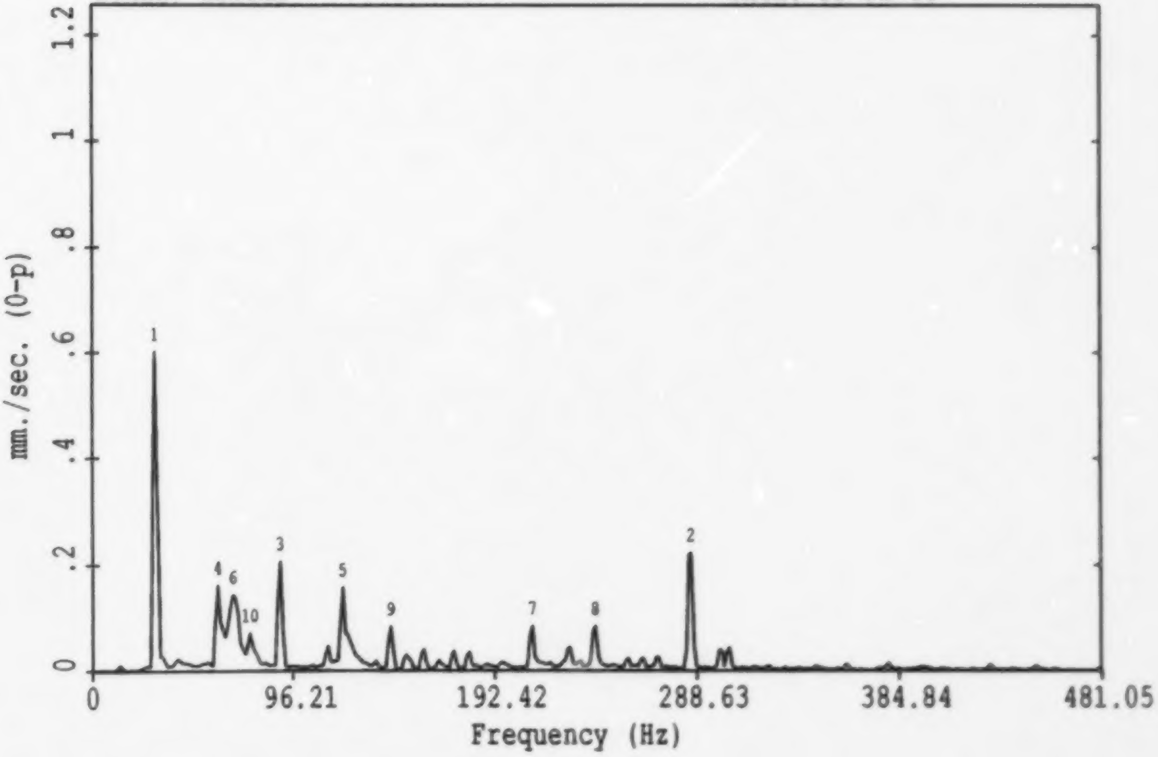


FIGURE B36

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator IB Casing Velocity Axial
PROCESS CONDITION : Load 4.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 0.66 |
| 2 | 286.2 | 0.21 |
| 3 | 67.3 | 0.20 |
| 4 | 90.2 | 0.14 |
| 5 | 120.3 | 0.12 |
| 6 | 60.1 | 0.11 |
| 7 | 143.1 | 0.08 |
| 8 | 122.7 | 0.07 |
| 9 | 210.5 | 0.07 |
| 10 | 75.8 | 0.07 |

SCALE: Linear

DATE: 08-11-88

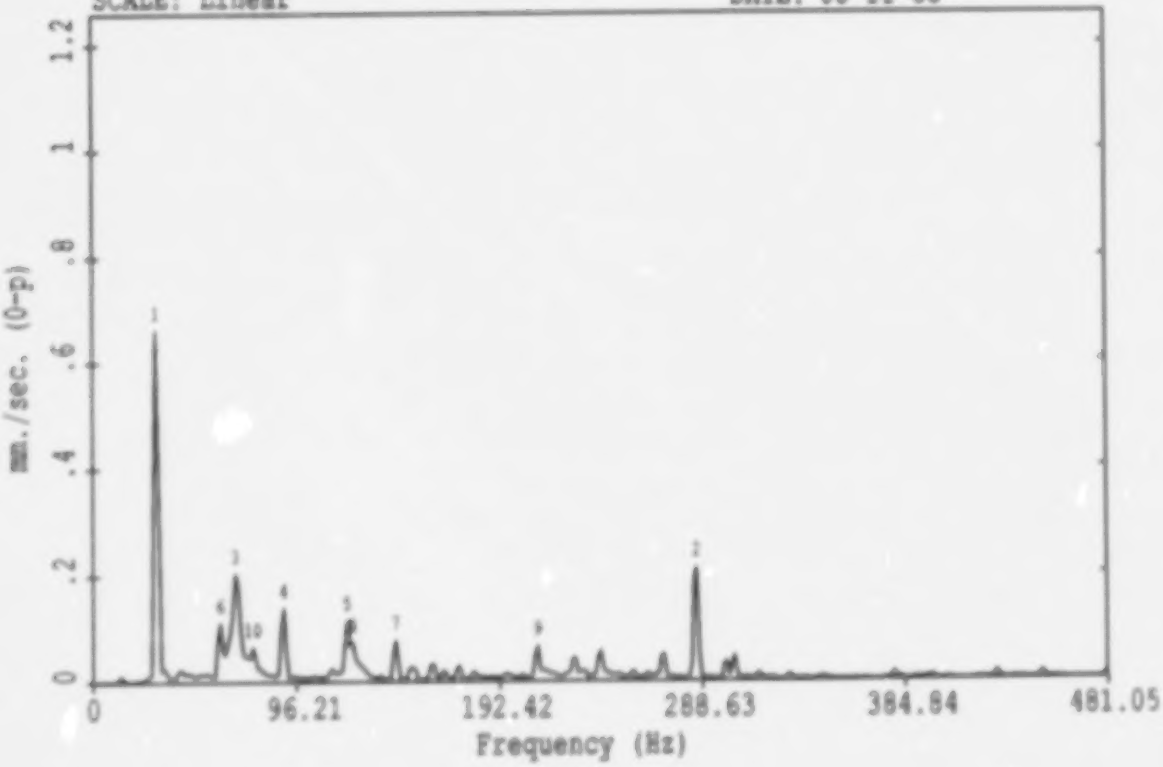


FIGURE B37

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator IB Casing Velocity Axial
PROCESS CONDITION : Load 5.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 0.77 |
| 2 | 67.3 | 0.22 |
| 3 | 286.2 | 0.18 |
| 4 | 120.3 | 0.12 |
| 5 | 75.8 | 0.11 |
| 6 | 90.2 | 0.11 |
| 7 | 60.1 | 0.09 |
| 8 | 143.1 | 0.08 |
| 9 | 270.6 | 0.07 |
| 10 | 162.4 | 0.07 |

SCALE: Linear

DATE: 08-11-88

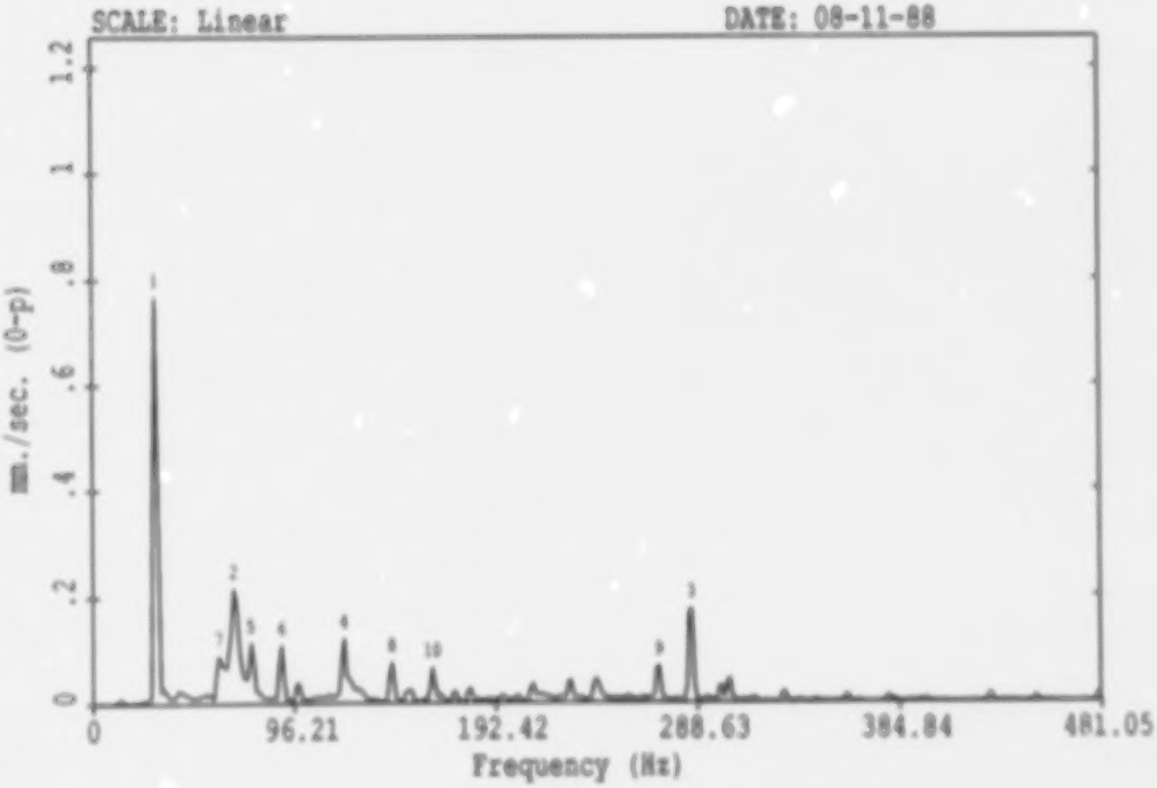


FIGURE B38

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator IB Casing Velocity Axial
PROCESS CONDITION : Load 6.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 0.83 |
| 2 | 240.5 | 0.21 |
| 3 | 67.3 | 0.19 |
| 4 | 286.2 | 0.16 |
| 5 | 167.2 | 0.12 |
| 6 | 90.2 | 0.10 |
| 7 | 75.8 | 0.10 |
| 8 | 120.3 | 0.09 |
| 9 | 60.1 | 0.09 |
| 10 | 270.6 | 0.08 |

SCALE: Linear

DATE: 08-11-88

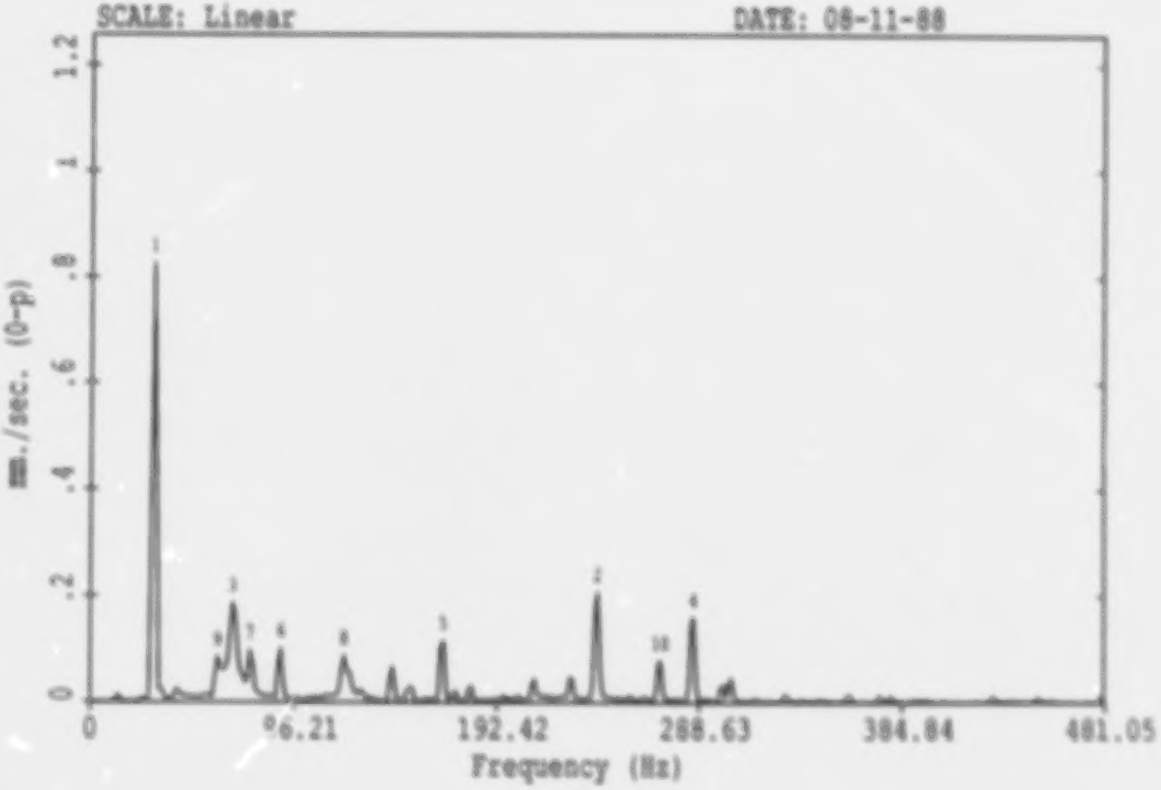


FIGURE B39

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator IB Casing Velocity Axial
PROCESS CONDITION : Load 6.9 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 0.88 |
| 2 | 67.3 | 0.22 |
| 3 | 286.2 | 0.15 |
| 4 | 240.5 | 0.13 |
| 5 | 75.8 | 0.09 |
| 6 | 270.6 | 0.08 |
| 7 | 60.1 | 0.08 |
| 8 | 90.2 | 0.08 |
| 9 | 62.5 | 0.08 |
| 10 | 143.1 | 0.07 |

SCALE: Linear DATE: 08-11-88

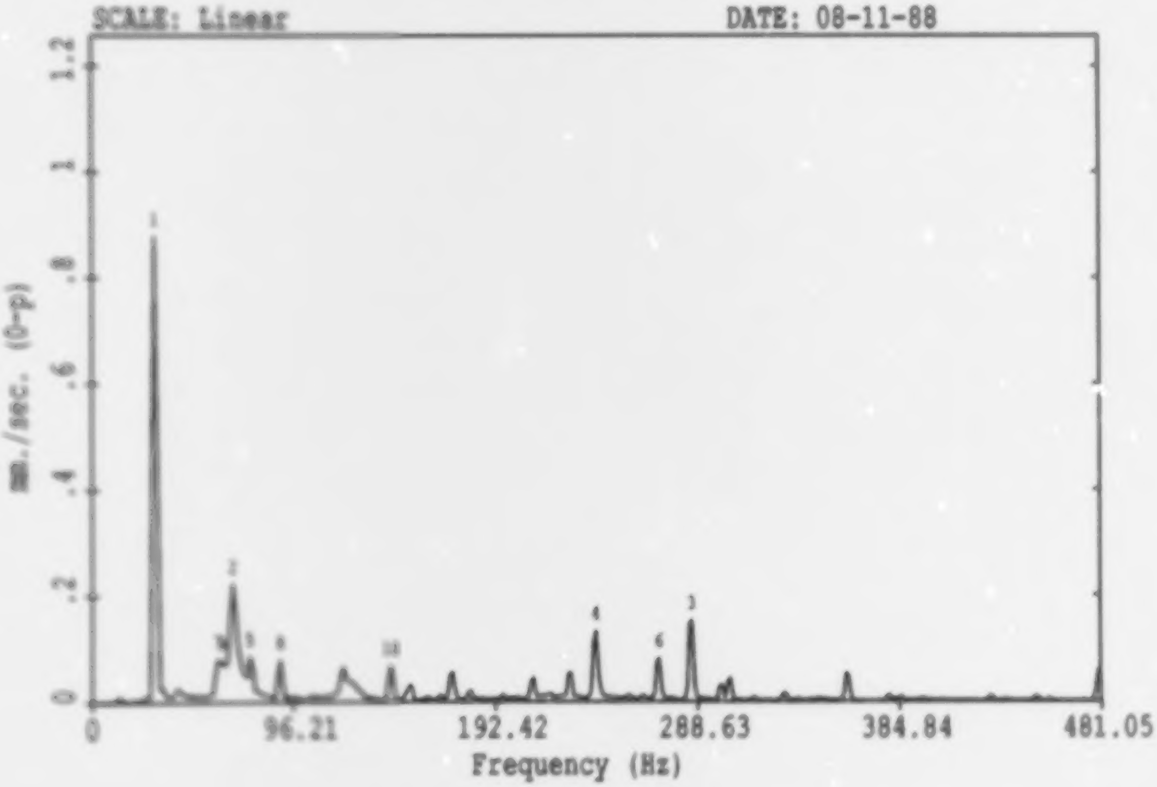


FIGURE B40

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator Shaft Displ. OB Brg Vert.
PROCESS CONDITION : Load 0.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 21.07 |
| 2 | 60.1 | 7.26 |
| 3 | 240.5 | 4.16 |
| 4 | 150.3 | 3.56 |
| 5 | 120.3 | 2.70 |
| 6 | 180.4 | 2.57 |
| 7 | 389.7 | 2.47 |
| 8 | 90.2 | 2.28 |
| 9 | 329.5 | 2.07 |
| 10 | 269.4 | 1.85 |

SCALE: Linear

DATE: 11-08-88

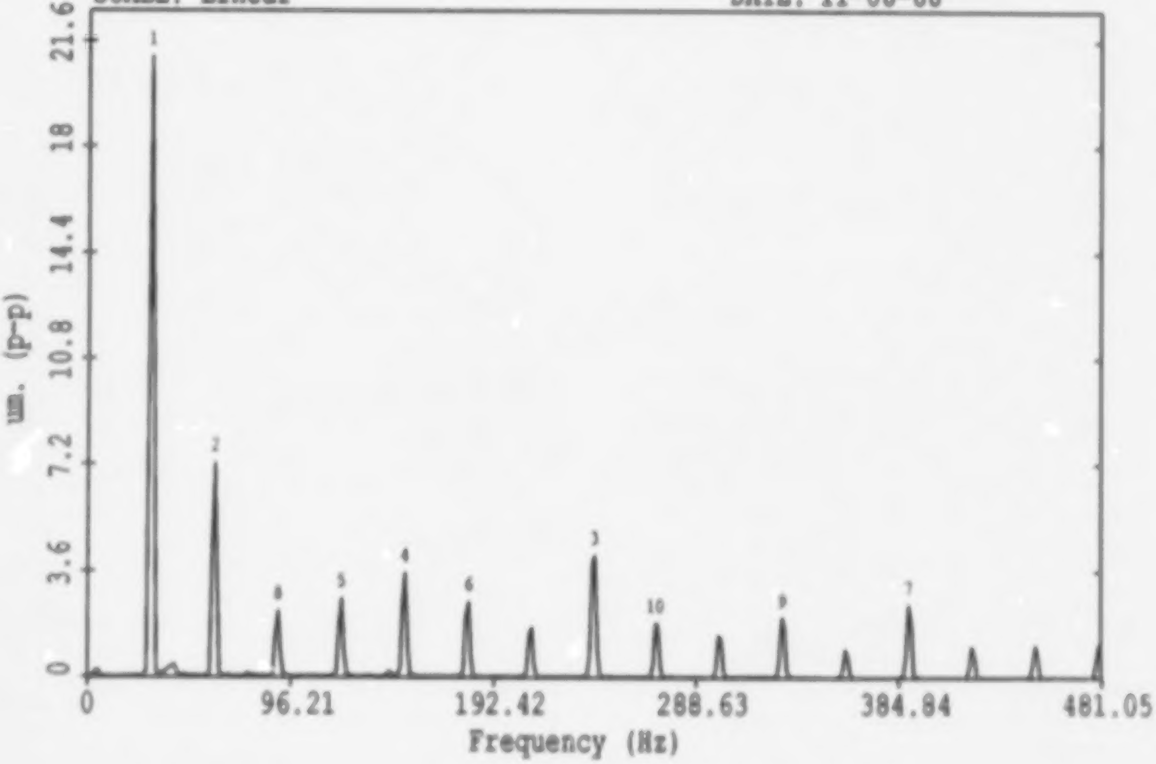


FIGURE B41

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator Shaft Displ. OB Brg Vert.
PROCESS CONDITION : Load 1.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 21.95 |
| 2 | 60.1 | 7.51 |
| 3 | 240.5 | 4.26 |
| 4 | 150.3 | 3.58 |
| 5 | 120.3 | 2.65 |
| 6 | 180.4 | 2.53 |
| 7 | 90.2 | 2.52 |
| 8 | 389.7 | 2.42 |
| 9 | 329.5 | 1.99 |
| 10 | 270.6 | 1.84 |

SCALE: Linear

DATE: 11-08-88

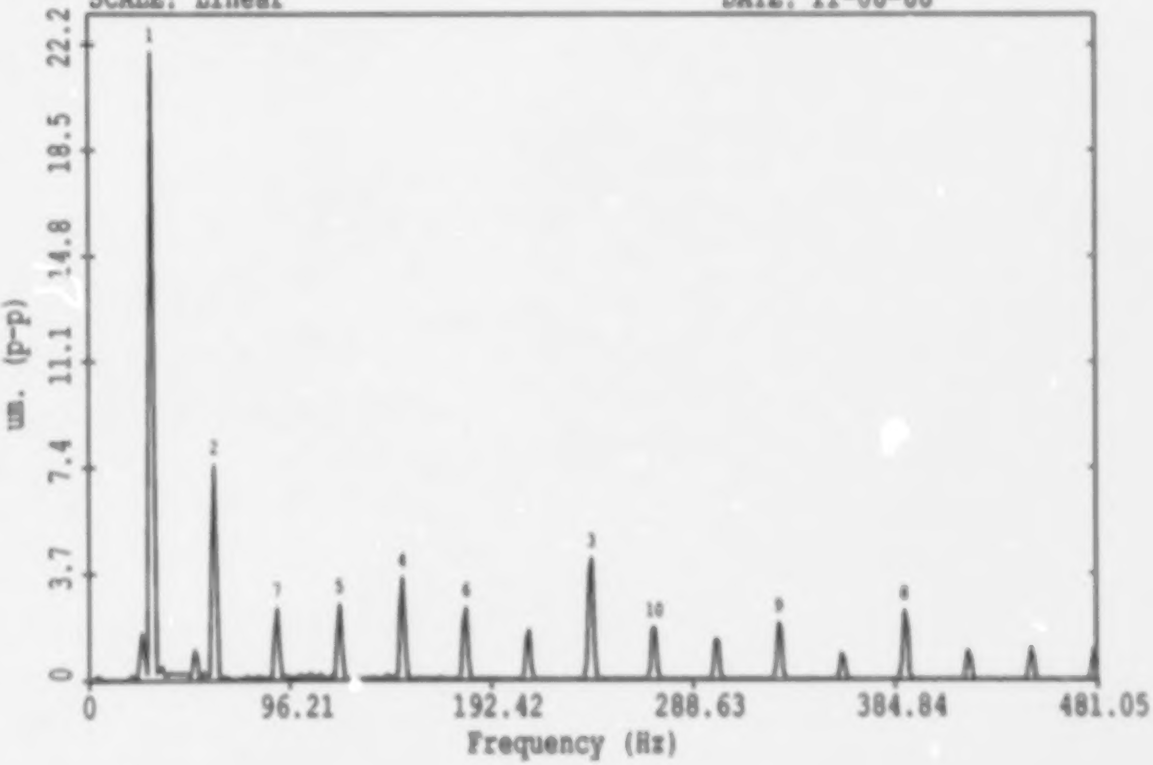


FIGURE B42

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator Shaft Displ. OB Brg Vert.
PROCESS CONDITION : Load 2.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 24.01 |
| 2 | 60.1 | 7.04 |
| 3 | 240.5 | 4.30 |
| 4 | 150.3 | 3.61 |
| 5 | 90.2 | 2.80 |
| 6 | 180.4 | 2.77 |
| 7 | 120.3 | 2.73 |
| 8 | 389.7 | 2.39 |
| 9 | 329.5 | 1.95 |
| 10 | 270.6 | 1.80 |

SCALE: Linear

DATE: 11-08-88

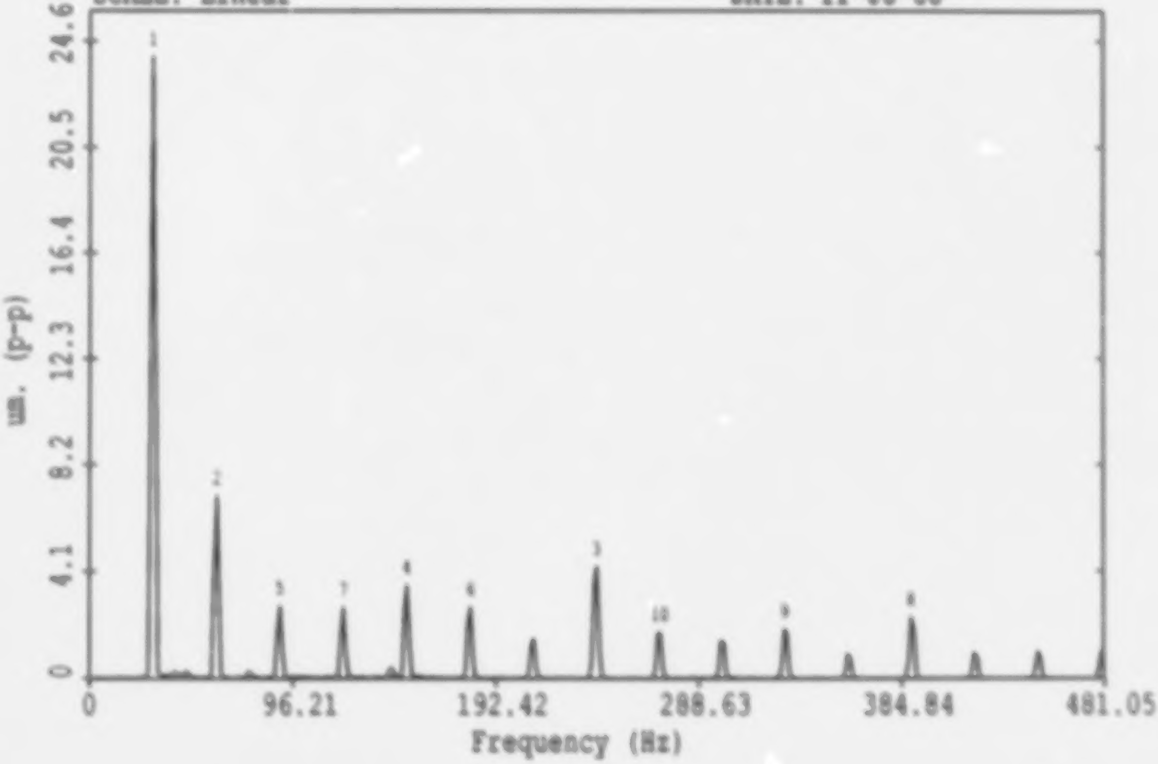


FIGURE B43

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator Shaft Displ. OB Brg Vert.
PROCESS CONDITION : Load 3.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 23.91 |
| 2 | 60.1 | 7.14 |
| 3 | 240.5 | 4.32 |
| 4 | 150.3 | 3.51 |
| 5 | 120.3 | 2.84 |
| 6 | 180.4 | 2.76 |
| 7 | 90.2 | 2.67 |
| 8 | 389.7 | 2.39 |
| 9 | 329.5 | 1.96 |
| 10 | 270.6 | 1.77 |

SCALE: Linear

DATE: 11-08-88

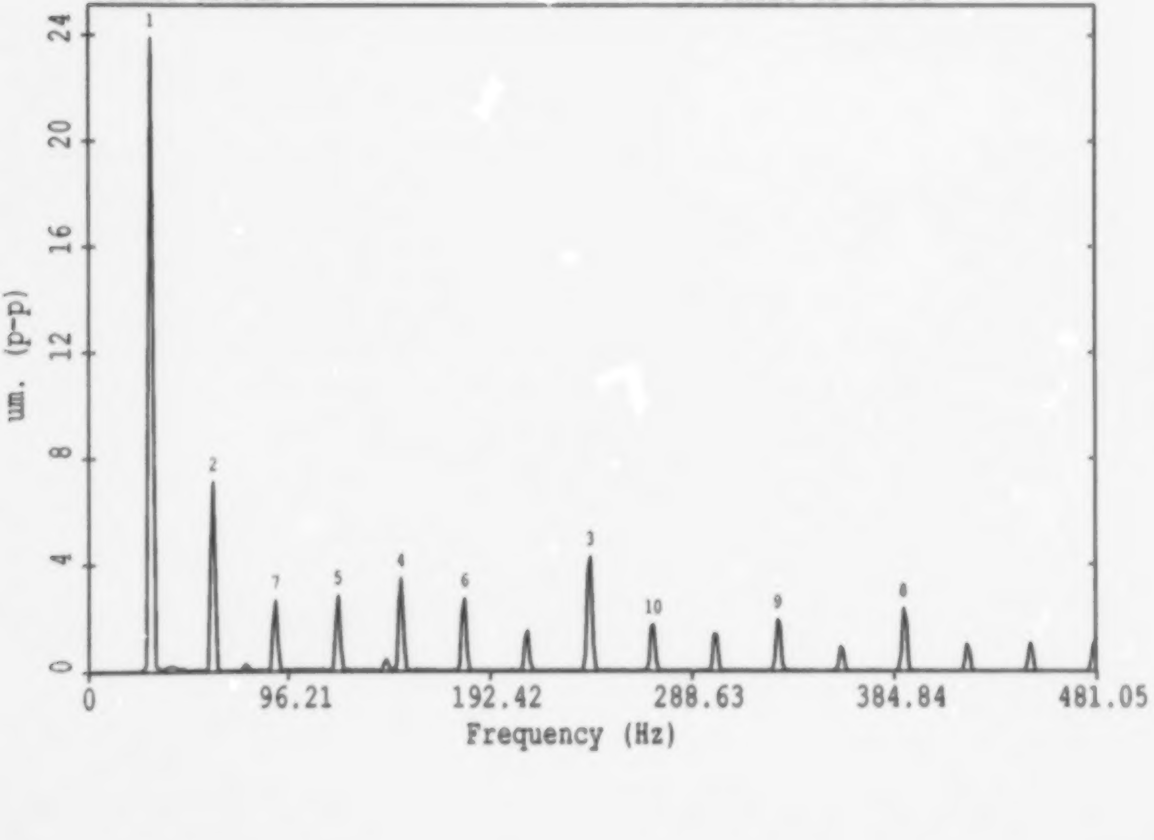


FIGURE B44

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator Shaft Displ. OB Brg Vert.
PROCESS CONDITION : Load 4.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 25.17 |
| 2 | 60.1 | 6.98 |
| 3 | 240.5 | 4.38 |
| 4 | 150.3 | 3.64 |
| 5 | 120.3 | 3.09 |
| 6 | 180.4 | 2.79 |
| 7 | 90.2 | 2.67 |
| 8 | 389.7 | 2.35 |
| 9 | 329.5 | 1.92 |
| 10 | 270.6 | 1.82 |

SCALE: Linear DATE: 11-08-88

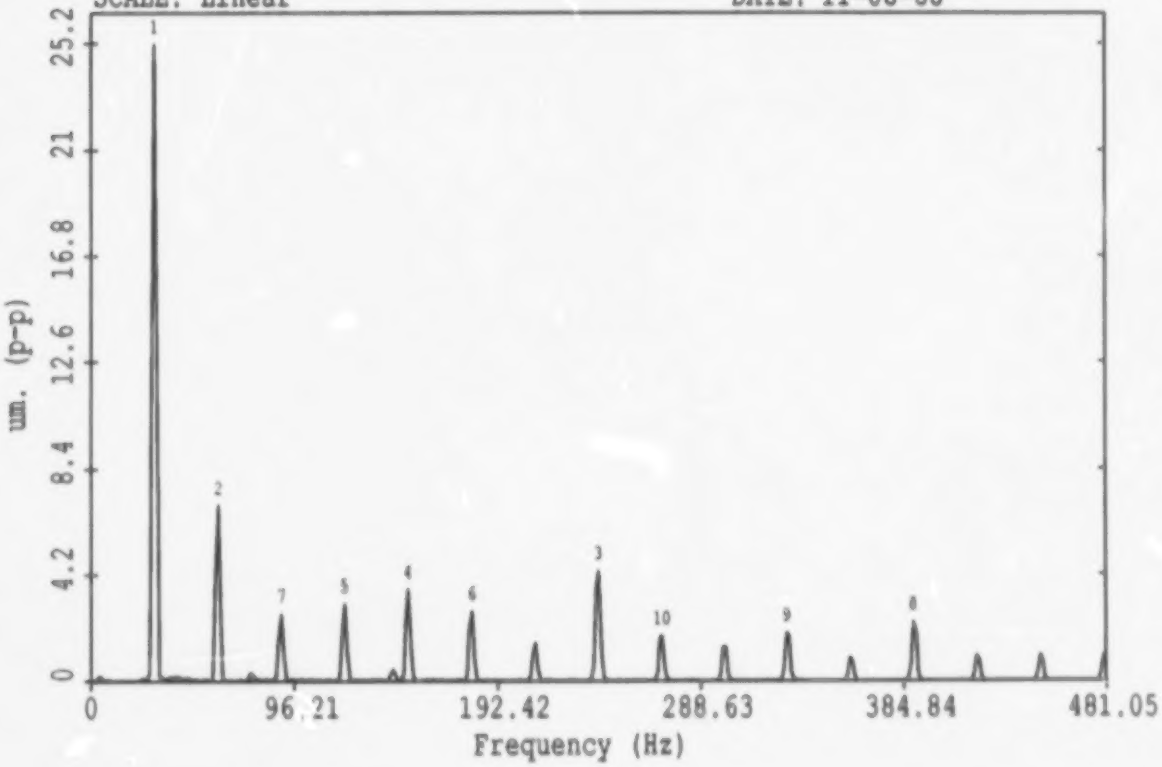


FIGURE B45

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator Shaft Displ. OB Brg Vert.
PROCESS CONDITION : Load 5.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 26.75 |
| 2 | 60.1 | 6.74 |
| 3 | 240.5 | 4.22 |
| 4 | 150.3 | 3.65 |
| 5 | 120.3 | 3.22 |
| 6 | 180.4 | 2.74 |
| 7 | 90.2 | 2.62 |
| 8 | 389.7 | 2.36 |
| 9 | 329.5 | 1.99 |
| 10 | 270.6 | 1.79 |

SCALE: Linear

DATE: 11-08-88

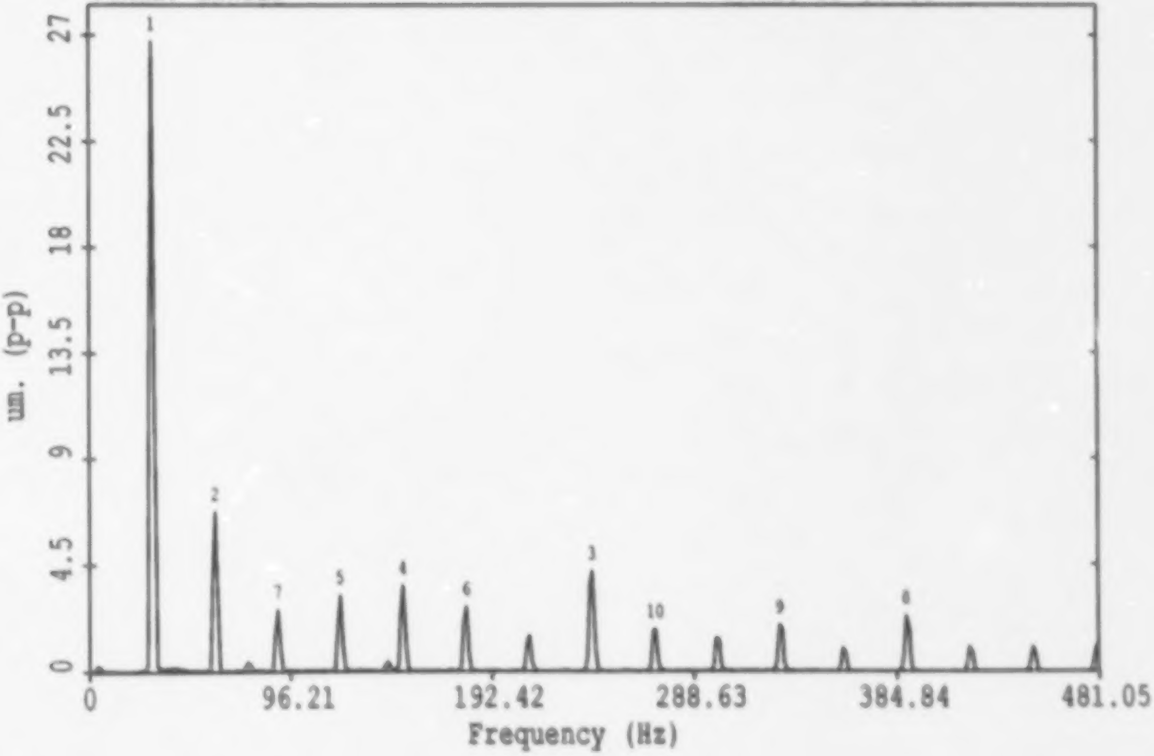


FIGURE B46

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator Shaft Displ. OB Brg Vert.
PROCESS CONDITION : Load 6.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 27.64 |
| 2 | 60.1 | 6.52 |
| 3 | 240.5 | 4.34 |
| 4 | 150.3 | 3.70 |
| 5 | 120.3 | 3.33 |
| 6 | 180.4 | 2.75 |
| 7 | 90.2 | 2.61 |
| 8 | 389.7 | 2.30 |
| 9 | 329.5 | 2.00 |
| 10 | 270.6 | 1.75 |

SCALE: Linear DATE: 11-08-86

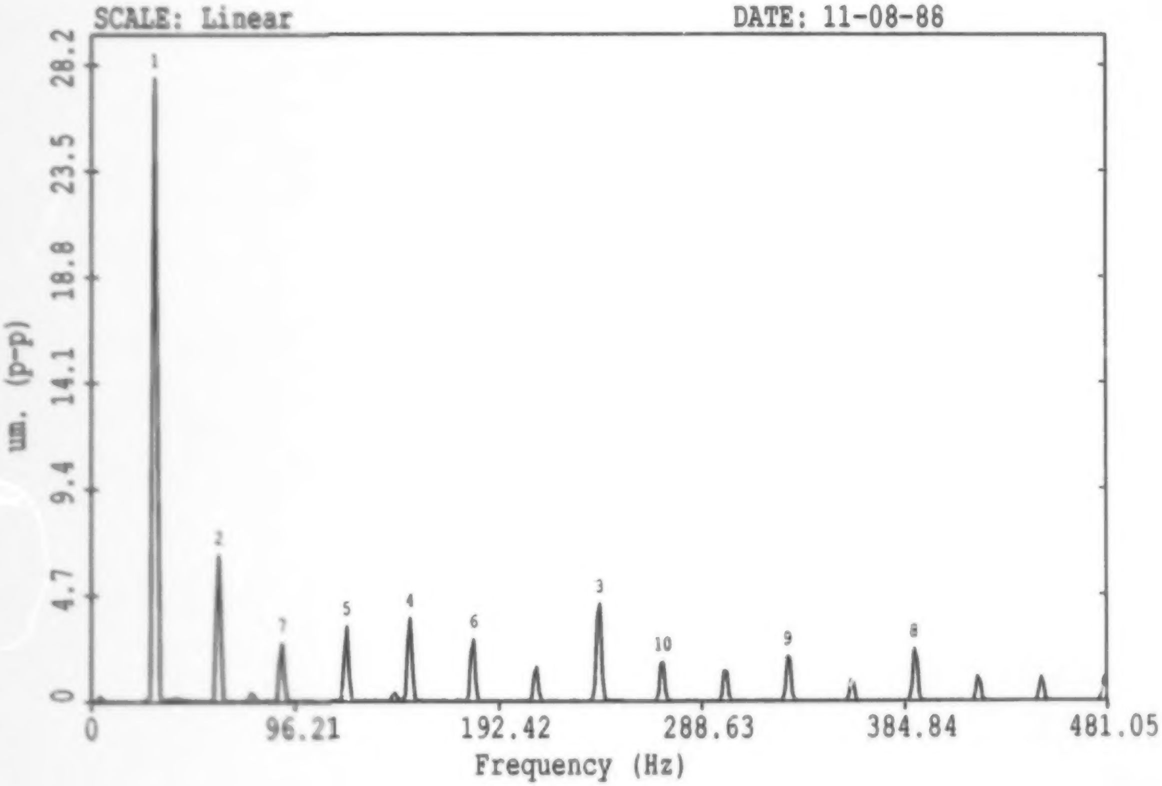


FIGURE B47

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator Shaft Displ. OB Brg Vert.
PROCESS CONDITION : Load 6.9 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 28.81 |
| 2 | 60.1 | 6.23 |
| 3 | 240.5 | 4.36 |
| 4 | 150.3 | 3.73 |
| 5 | 120.3 | 3.38 |
| 6 | 180.4 | 2.75 |
| 7 | 90.2 | 2.54 |
| 8 | 389.7 | 2.29 |
| 9 | 329.5 | 1.91 |
| 10 | 270.6 | 1.78 |

SCALE: Linear

DATE: 11-08-88

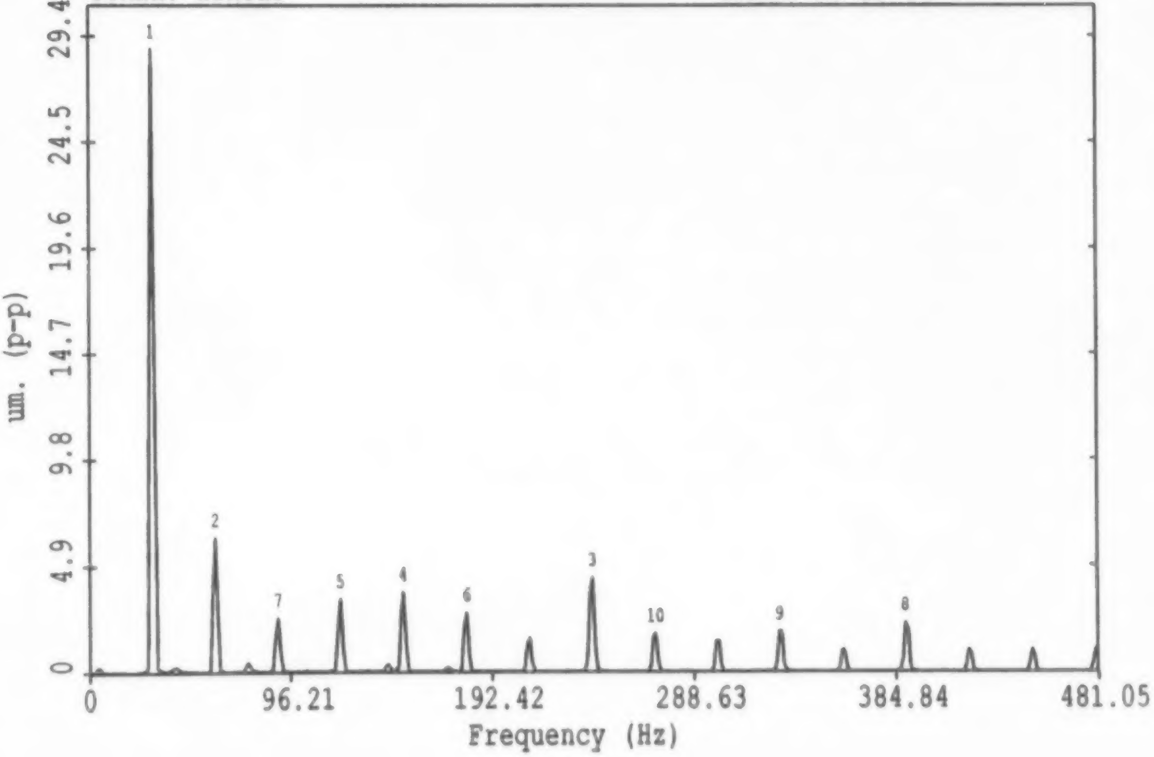


**FIGURE B48**

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator Shaft Displ. OB Brg Hor.
PROCESS CONDITION : Load 0.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 12.98 |
| 2 | 60.1 | 9.08 |
| 3 | 240.5 | 4.07 |
| 4 | 150.3 | 4.02 |
| 5 | 120.3 | 3.05 |
| 6 | 180.4 | 2.88 |
| 7 | 90.2 | 2.68 |
| 8 | 389.7 | 2.47 |
| 9 | 329.5 | 2.16 |
| 10 | 269.4 | 1.84 |

SCALE: Linear

DATE: 11-08-88

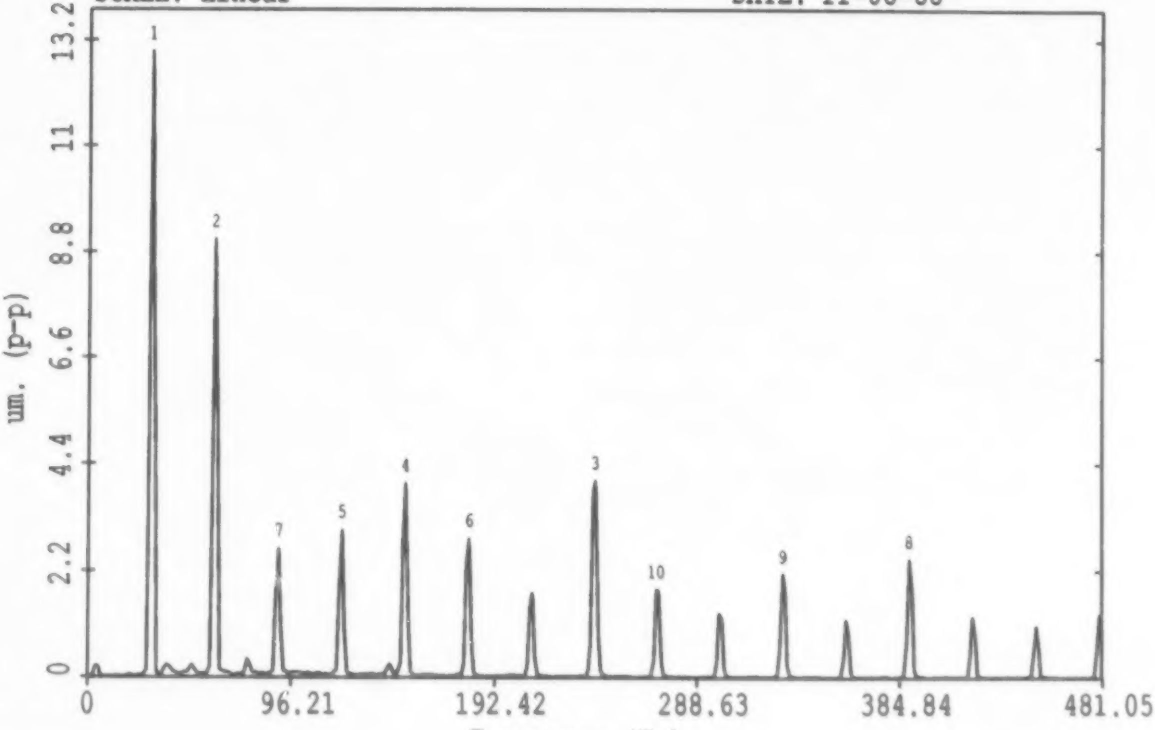


FIGURE B49

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator Shaft Displ. OB Brg Hor.
PROCESS CONDITION : Load 1.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 14.24 |
| 2 | 60.1 | 9.77 |
| 3 | 240.5 | 4.16 |
| 4 | 150.3 | 4.00 |
| 5 | 120.3 | 3.02 |
| 6 | 180.4 | 2.87 |
| 7 | 90.2 | 2.84 |
| 8 | 389.7 | 2.41 |
| 9 | 50.5 | 2.11 |
| 10 | 329.5 | 2.09 |

SCALE: Linear

DATE: 11-08-88

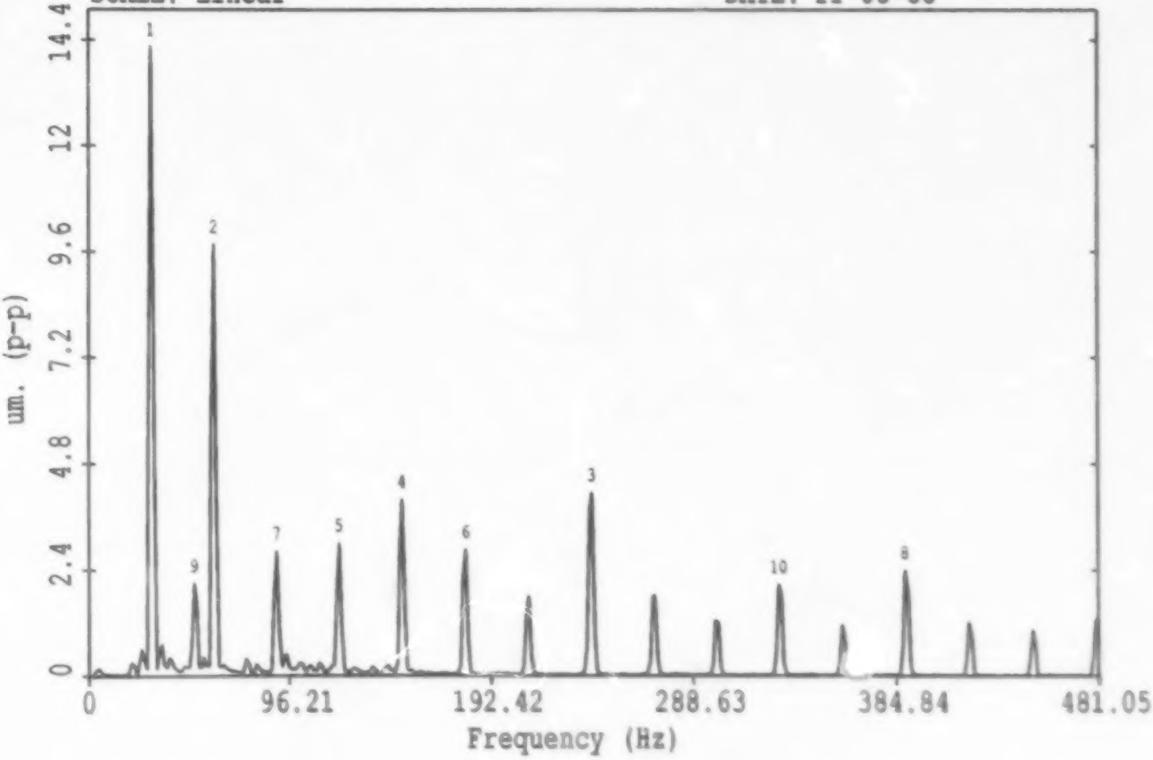


FIGURE B50

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator Shaft Displ. OB Brg Hor.
PROCESS CONDITION : Load 2.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 18.70 |
| 2 | 60.1 | 9.85 |
| 3 | 150.3 | 4.22 |
| 4 | 240.5 | 4.20 |
| 5 | 180.4 | 3.15 |
| 6 | 90.2 | 2.72 |
| 7 | 120.3 | 2.64 |
| 8 | 389.7 | 2.38 |
| 9 | 329.5 | 2.03 |
| 10 | 270.6 | 1.75 |

SCALE: Linear

DATE: 11-08-88

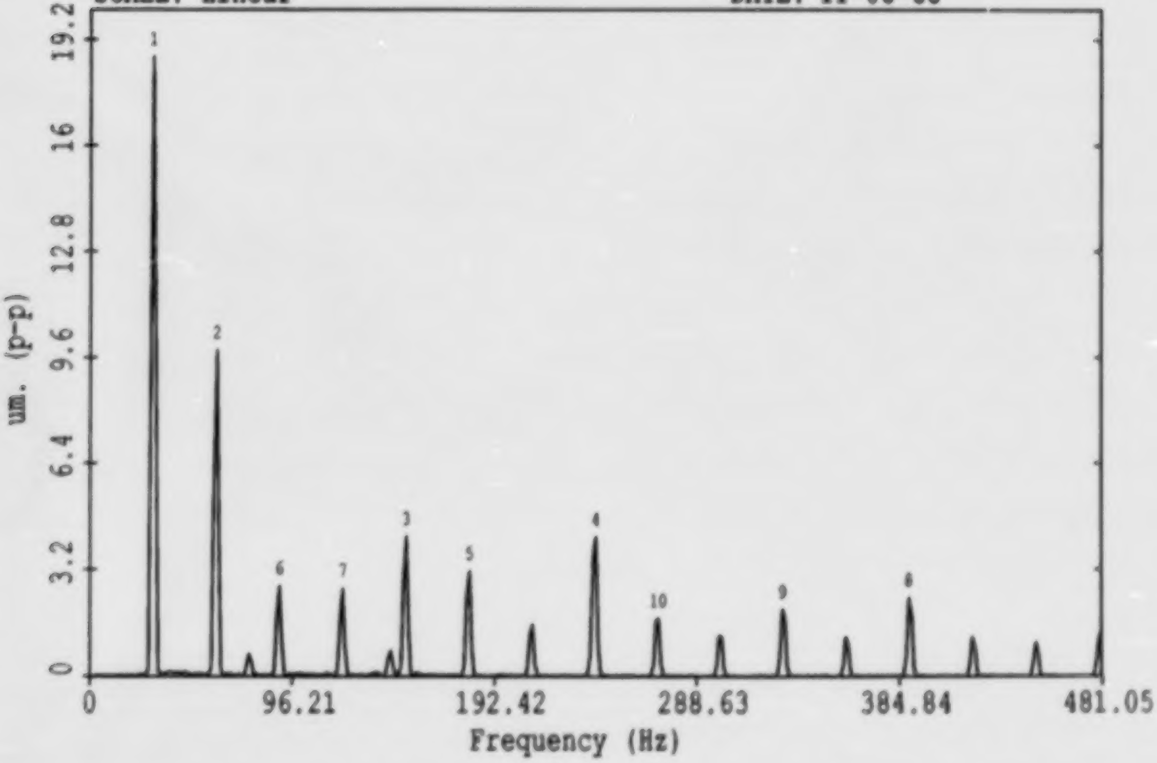


FIGURE B51

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator Shaft Displ. OB Brg Hor.
PROCESS CONDITION : Load 3.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 20.99 |
| 2 | 60.1 | 10.35 |
| 3 | 240.5 | 4.22 |
| 4 | 150.3 | 4.13 |
| 5 | 180.4 | 3.24 |
| 6 | 90.2 | 2.94 |
| 7 | 120.3 | 2.62 |
| 8 | 389.7 | 2.39 |
| 9 | 329.5 | 2.04 |
| 10 | 270.6 | 1.74 |

SCALE: Linear

DATE: 11-08-88

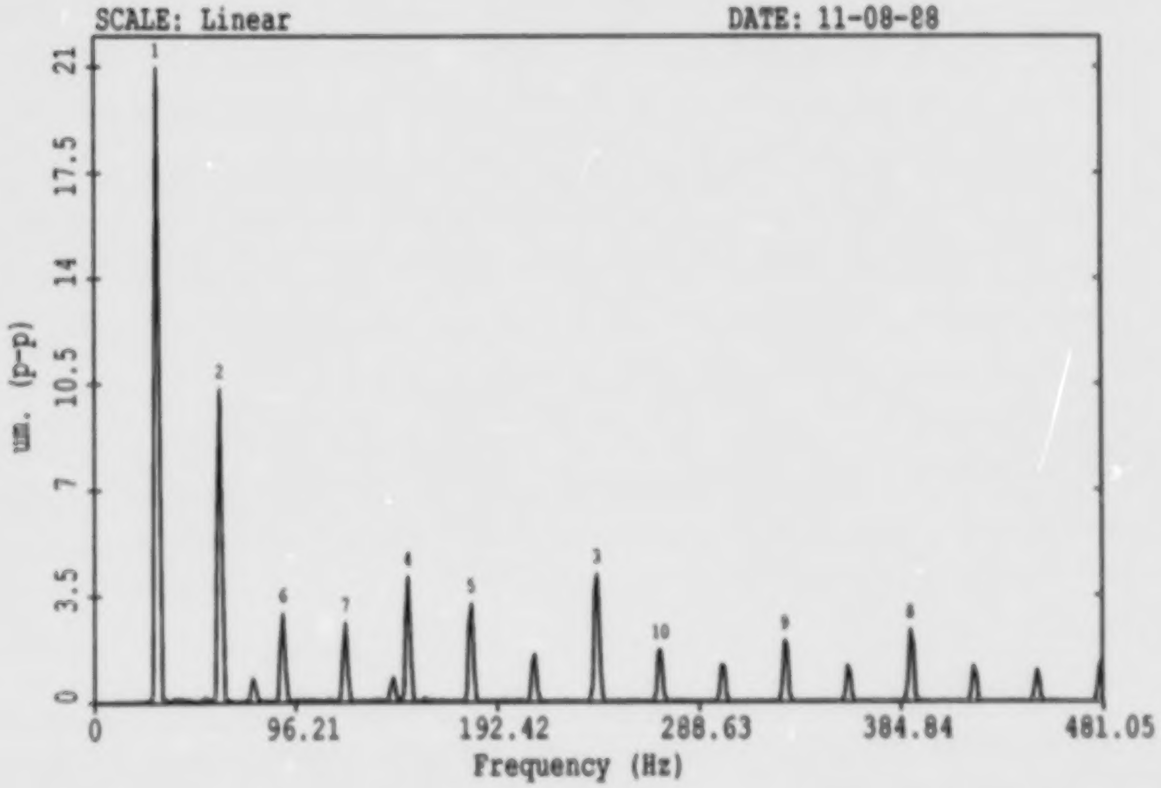
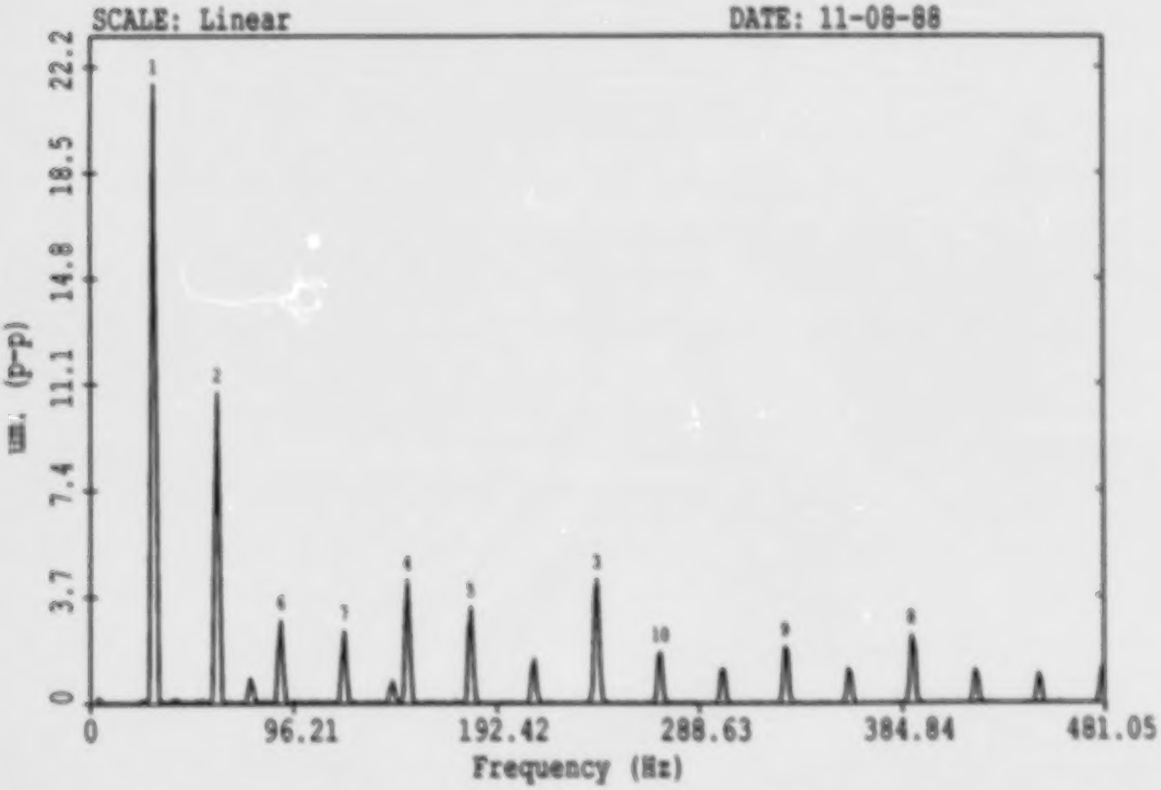


FIGURE B52

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator Shaft Displ. OB Brg Hor.
PROCESS CONDITION : Load 4.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 21.60 |
| 2 | 60.1 | 10.83 |
| 3 | 240.5 | 4.32 |
| 4 | 150.3 | 4.27 |
| 5 | 180.4 | 3.34 |
| 6 | 90.2 | 2.91 |
| 7 | 120.3 | 2.53 |
| 8 | 389.7 | 2.37 |
| 9 | 329.5 | 1.98 |
| 10 | 270.6 | 1.80 |



SCALE: Linear
DATE: 11-08-88

FIGURE B53

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator Shaft Displ. OB Brg Hor.
PROCESS CONDITION : Load 5.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 23.59 |
| 2 | 60.1 | 11.35 |
| 3 | 150.3 | 4.28 |
| 4 | 240.5 | 4.20 |
| 5 | 180.4 | 3.30 |
| 6 | 90.2 | 2.84 |
| 7 | 120.3 | 2.49 |
| 8 | 389.7 | 2.38 |
| 9 | 329.5 | 2.04 |
| 10 | 270.6 | 1.78 |

SCALE: Linear DATE: 11-08-88

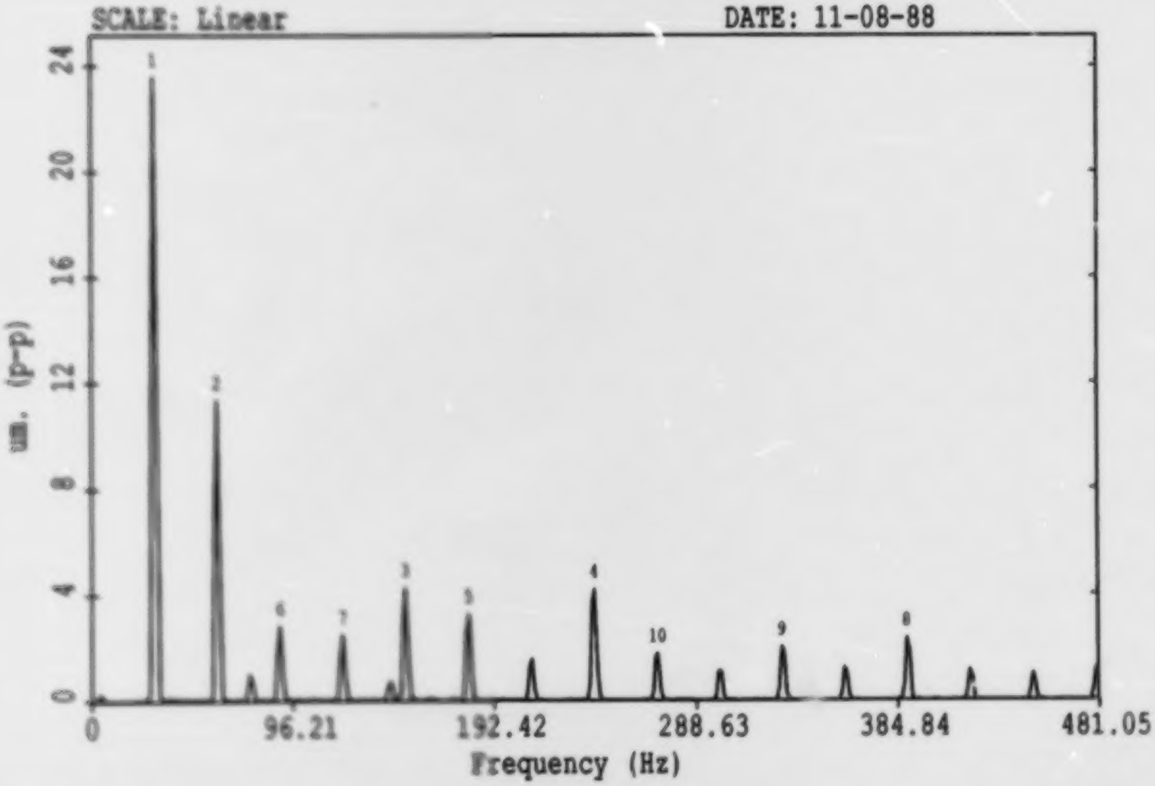


FIGURE B54

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator Shaft Displ. OB Brg Hor.
PROCESS CONDITION : Load 6.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 24.84 |
| 2 | 60.1 | 11.77 |
| 3 | 150.3 | 4.31 |
| 4 | 240.5 | 4.24 |
| 5 | 180.4 | 3.28 |
| 6 | 90.2 | 2.79 |
| 7 | 120.3 | 2.45 |
| 8 | 389.7 | 2.31 |
| 9 | 329.5 | 2.05 |
| 10 | 270.6 | 1.71 |

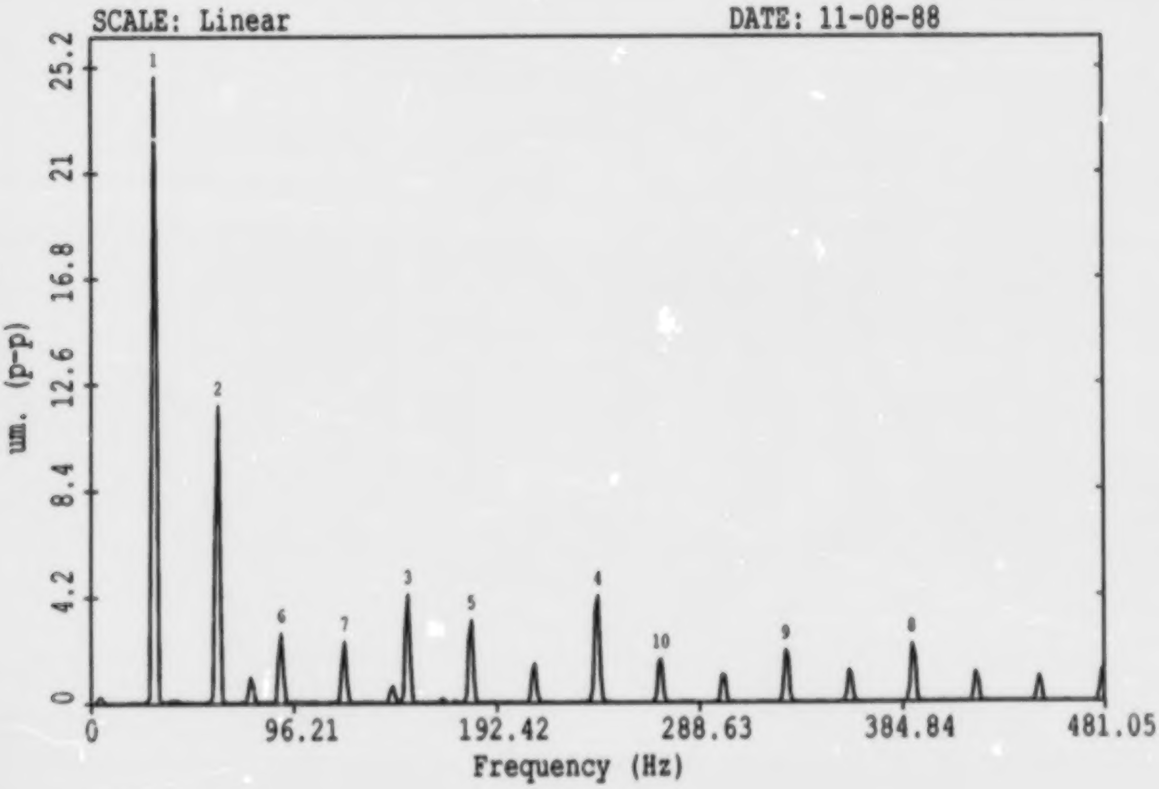


FIGURE B55

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator Shaft Displ. OB Brg Hor.
PROCESS CONDITION : Load 6.9 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 25.69 |
| 2 | 60.1 | 12.19 |
| 3 | 240.5 | 4.31 |
| 4 | 150.3 | 4.29 |
| 5 | 180.4 | 3.28 |
| 6 | 90.2 | 2.66 |
| 7 | 120.3 | 2.48 |
| 8 | 389.7 | 2.26 |
| 9 | 329.5 | 2.00 |
| 10 | 270.6 | 1.74 |

SCALE: Linear DATE: 11-08-88

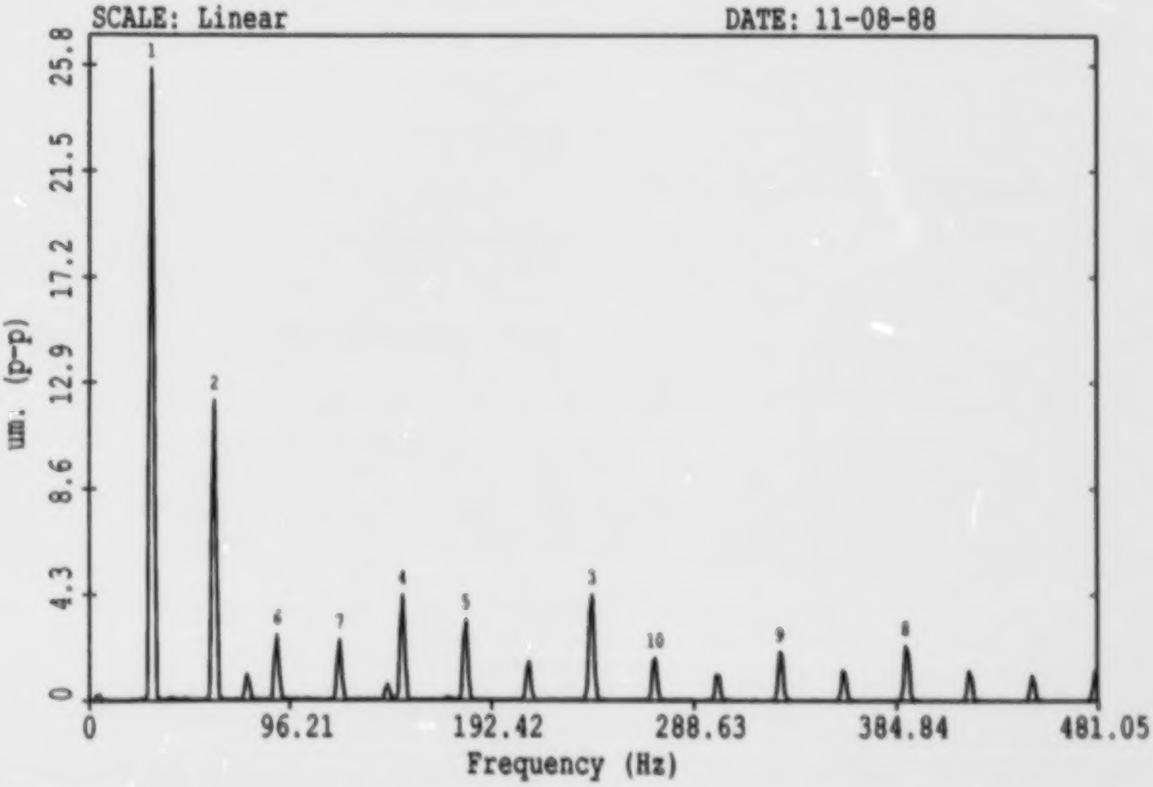


FIGURE B56

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator Shaft Displ. IB Brg Vert.
PROCESS CONDITION : Load 0.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 9.14 |
| 2 | 60.1 | 7.73 |
| 3 | 90.2 | 4.07 |
| 4 | 150.3 | 3.12 |
| 5 | 120.3 | 2.96 |
| 6 | 299.5 | 1.76 |
| 7 | 210.5 | 1.45 |
| 8 | 269.4 | 1.04 |
| 9 | 329.5 | 0.85 |
| 10 | 419.7 | 0.71 |

SCALE: Linear DATE: 11-08-88

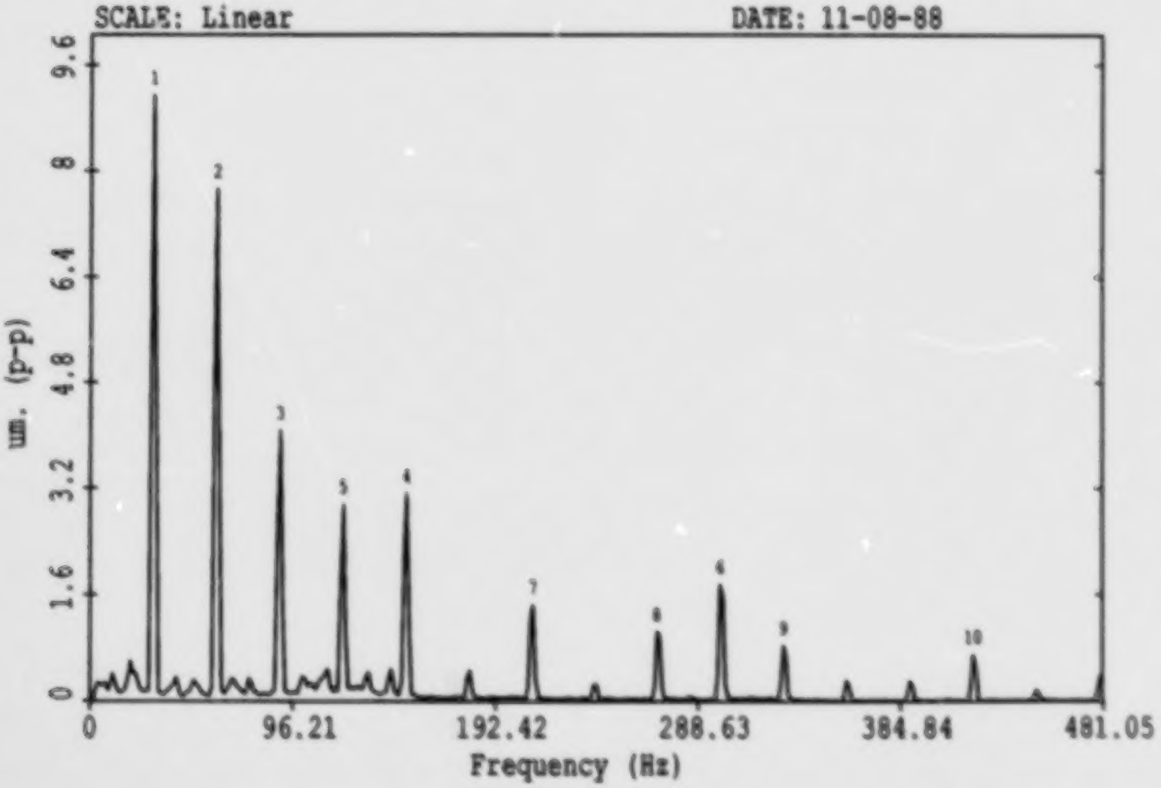


FIGURE B57

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator Shaft Displ. IB Brg Vert.
PROCESS CONDITION : Load 1.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 25.3 | 12.44 |
| 2 | 30.1 | 9.05 |
| 3 | 60.1 | 8.52 |
| 4 | 90.2 | 4.60 |
| 5 | 150.3 | 3.02 |
| 6 | 120.3 | 2.52 |
| 7 | 50.5 | 2.00 |
| 8 | 299.5 | 1.73 |
| 9 | 34.9 | 1.72 |
| 10 | 210.5 | 1.51 |

SCALE: Linear

DATE: 11-08-88

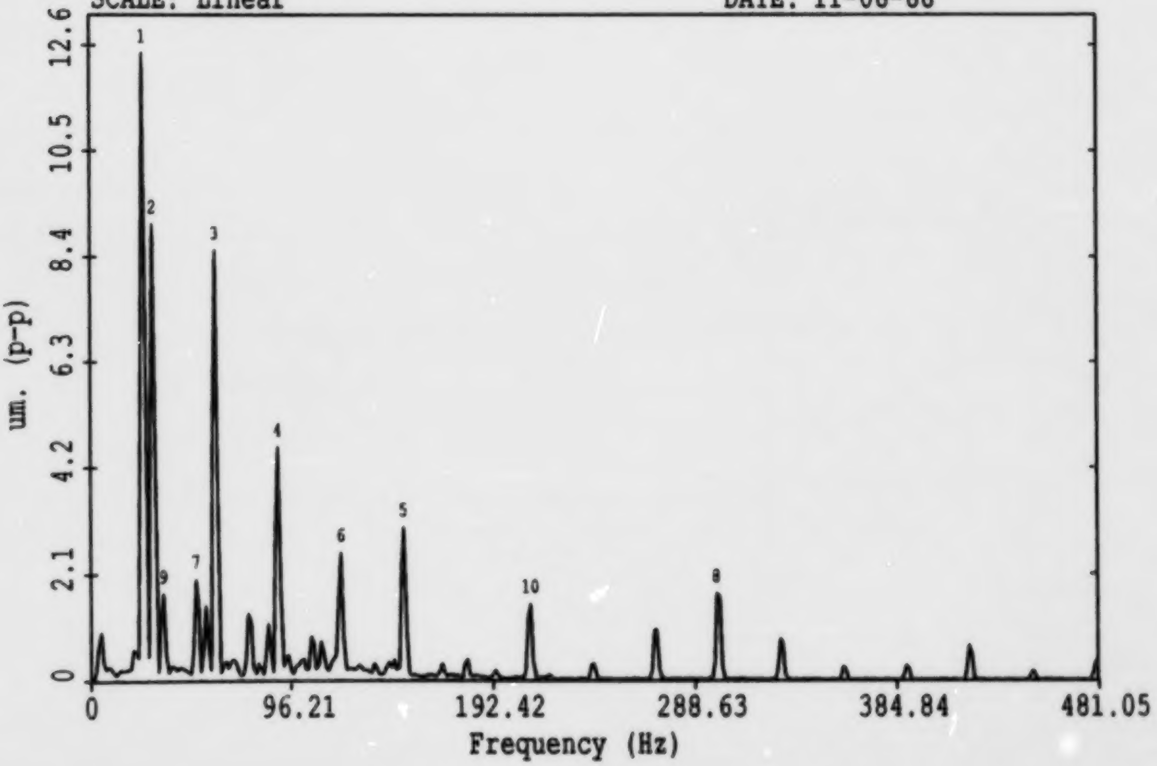


FIGURE B58

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator Shaft Displ. IB Brg Vert.
PROCESS CONDITION : Load 2.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 90.2 | 5.44 |
| 2 | 60.1 | 5.05 |
| 3 | 30.1 | 4.73 |
| 4 | 120.3 | 3.26 |
| 5 | 150.3 | 3.17 |
| 6 | 299.5 | 1.76 |
| 7 | 210.5 | 1.40 |
| 8 | 75.8 | 1.12 |
| 9 | 270.6 | 1.07 |
| 10 | 329.5 | 0.83 |

SCALE: Linear DATE: 11-08-88

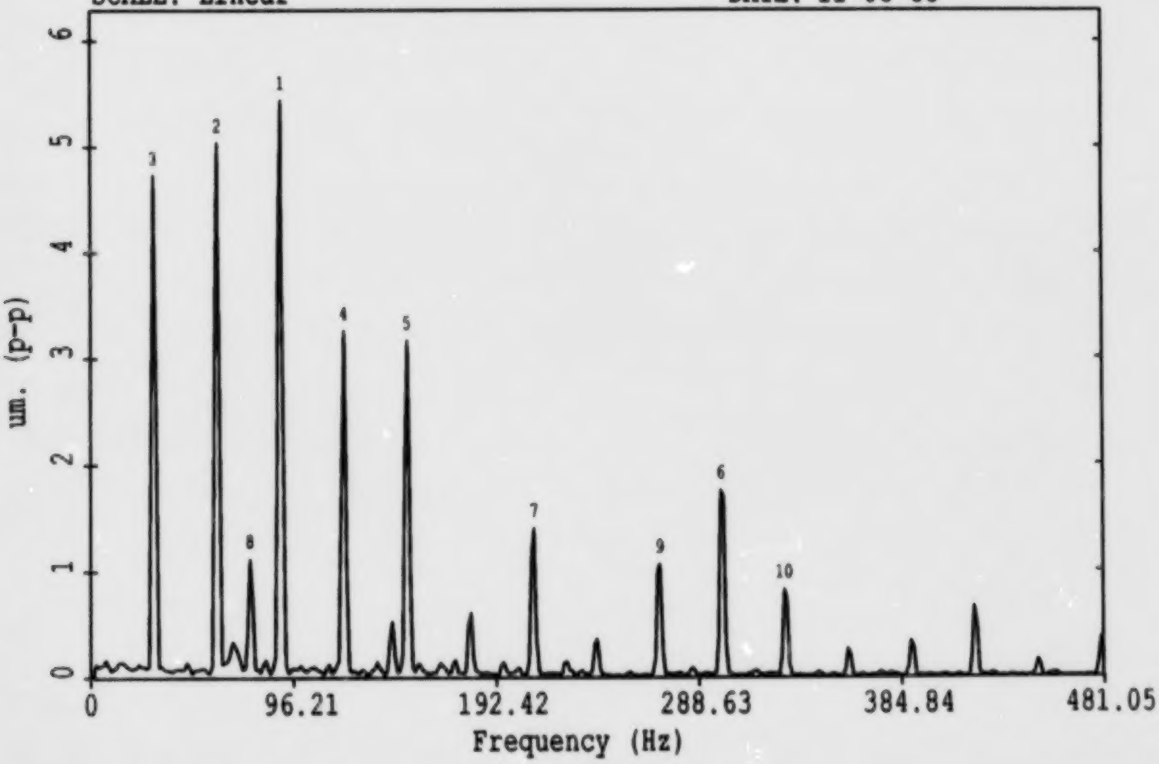


FIGURE B59

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator Shaft Displ. IB Brg Vert.
PROCESS CONDITION : Load 3.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 5.39 |
| 2 | 90.2 | 4.91 |
| 3 | 60.1 | 4.43 |
| 4 | 120.3 | 3.30 |
| 5 | 150.3 | 3.05 |
| 6 | 299.5 | 1.75 |
| 7 | 210.5 | 1.42 |
| 8 | 75.8 | 1.29 |
| 9 | 270.6 | 1.01 |
| 10 | 329.5 | 0.85 |

SCALE: Linear DATE: 11-08-88

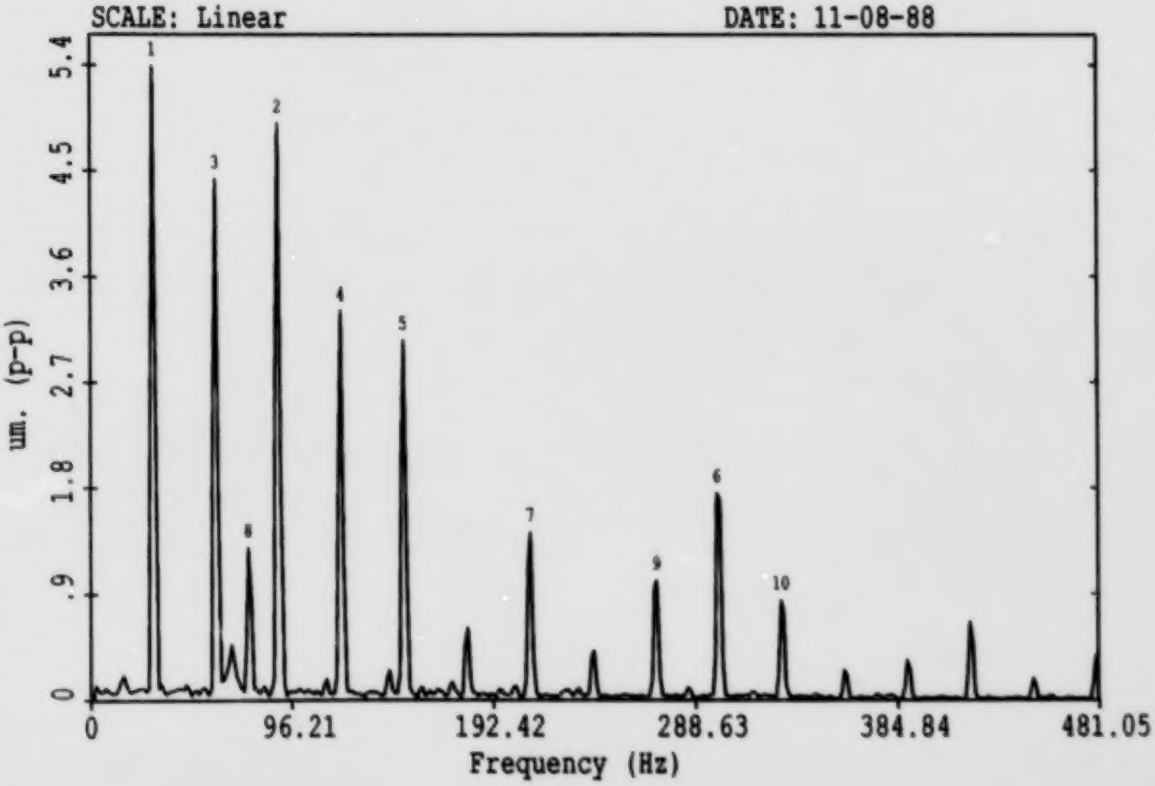


FIGURE B60

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator Shaft Displ. IB Brg Vert.
PROCESS CONDITION : Load 4.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 90.2 | 4.72 |
| 2 | 60.1 | 4.69 |
| 3 | 120.3 | 3.44 |
| 4 | 150.3 | 3.24 |
| 5 | 30.1 | 2.59 |
| 6 | 300.7 | 1.72 |
| 7 | 75.8 | 1.43 |
| 8 | 210.5 | 1.42 |
| 9 | 270.6 | 1.05 |
| 10 | 329.5 | 0.81 |

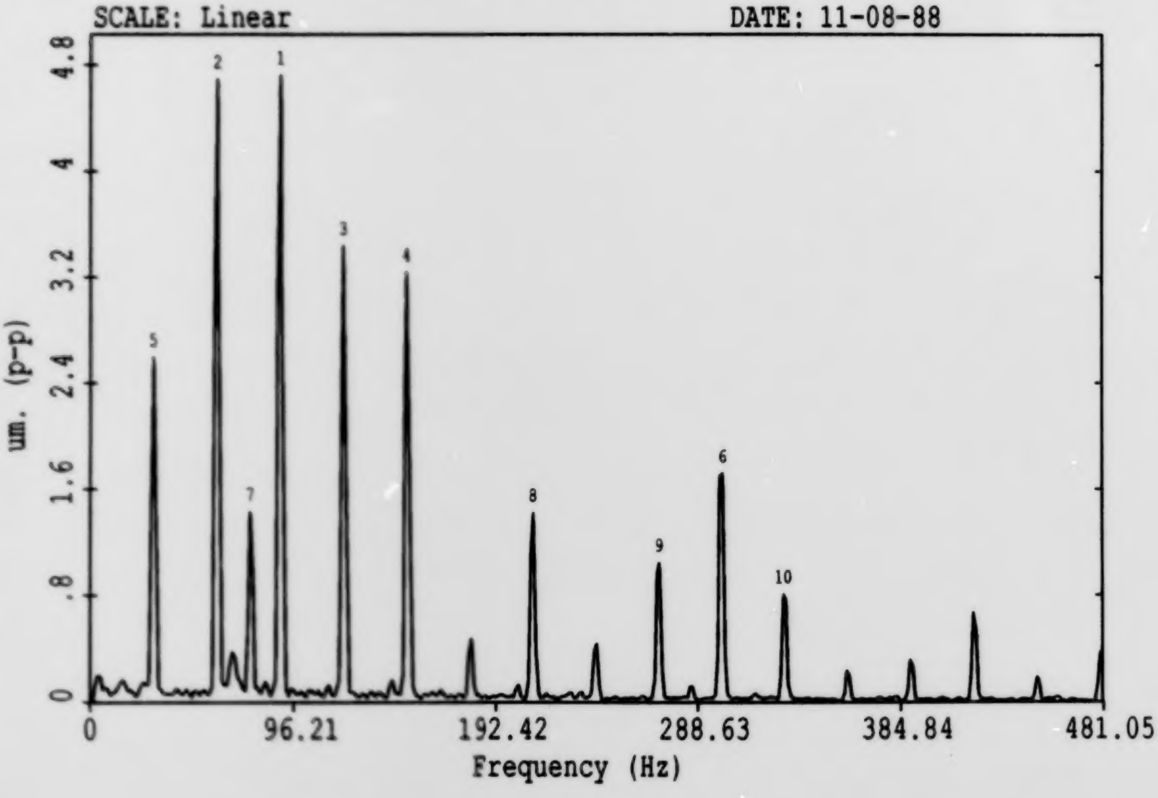

SCALE: Linear DATE: 11-08-88

FIGURE B61

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator Shaft Displ. IB Brg Vert.
PROCESS CONDITION : Load 5.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 90.2 | 4.68 |
| 2 | 60.1 | 4.64 |
| 3 | 120.3 | 3.53 |
| 4 | 150.3 | 3.26 |
| 5 | 30.1 | 2.68 |
| 6 | 299.5 | 1.73 |
| 7 | 75.8 | 1.54 |
| 8 | 210.5 | 1.44 |
| 9 | 270.6 | 1.04 |
| 10 | 329.5 | 0.84 |

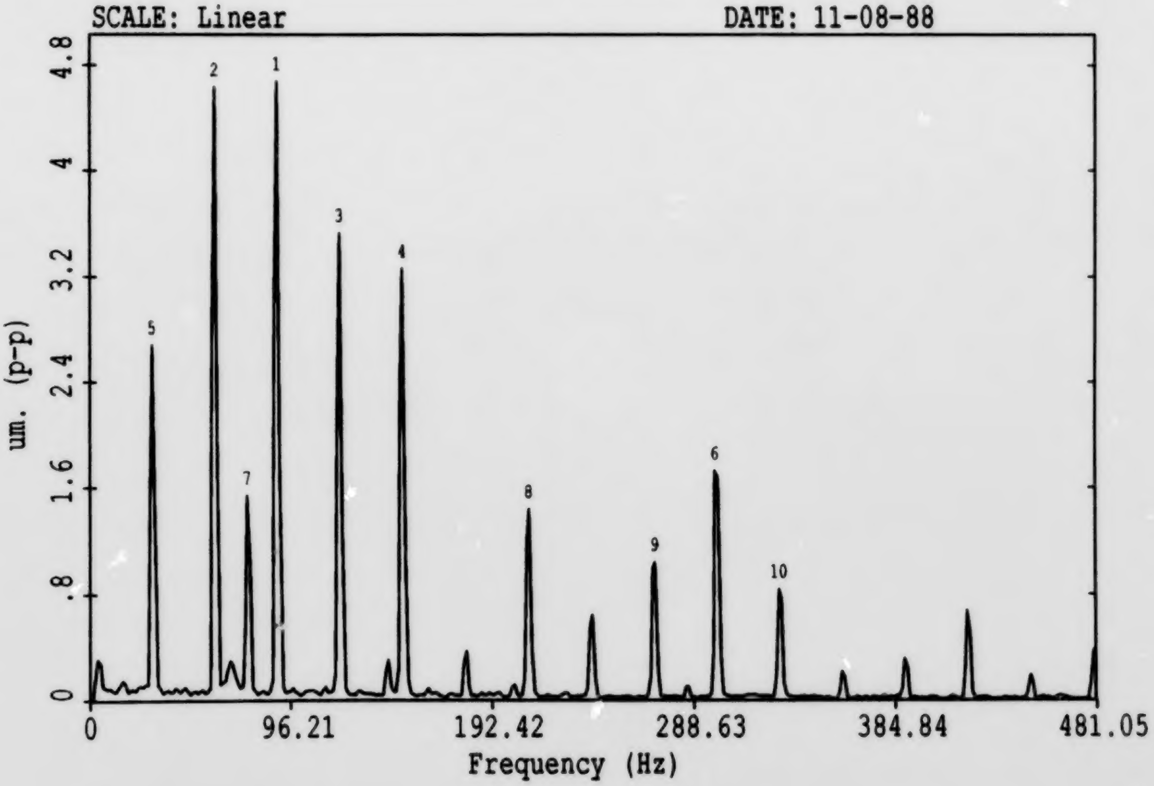


FIGURE B62

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator Shaft Displ. IB Brg Vert.
PROCESS CONDITION : Load 6.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 90.2 | 4.64 |
| 2 | 60.1 | 4.49 |
| 3 | 30.1 | 4.02 |
| 4 | 120.3 | 3.66 |
| 5 | 150.3 | 3.31 |
| 6 | 299.5 | 1.69 |
| 7 | 75.8 | 1.61 |
| 8 | 210.5 | 1.45 |
| 9 | 270.6 | 1.05 |
| 10 | 329.5 | 0.83 |

SCALE: Linear

DATE: 11-08-88

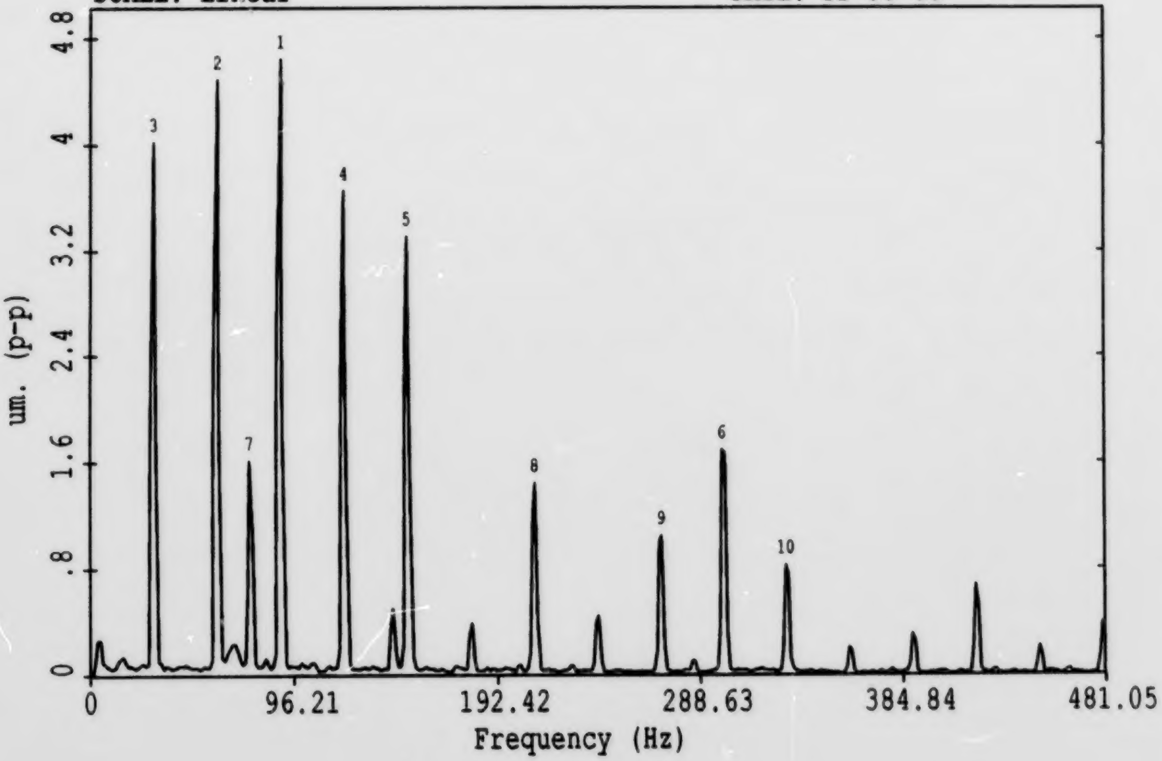
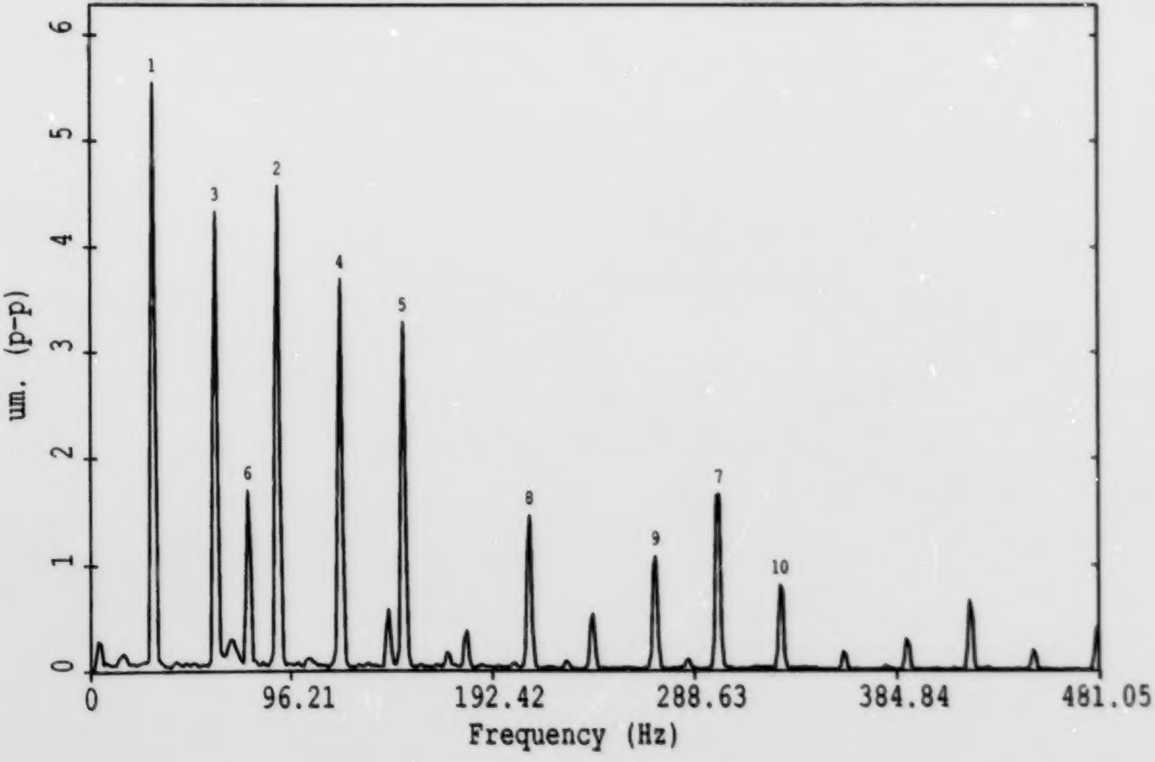


FIGURE B63

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator Shaft Displ. IB Brg Vert.
PROCESS CONDITION : Load 6.9 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 5.56 |
| 2 | 90.2 | 4.58 |
| 3 | 60.1 | 4.34 |
| 4 | 120.3 | 3.70 |
| 5 | 150.3 | 3.29 |
| 6 | 75.8 | 1.70 |
| 7 | 300.7 | 1.66 |
| 8 | 210.5 | 1.46 |
| 9 | 270.6 | 1.08 |
| 10 | 329.5 | 0.82 |



SCALE: Linear DATE: 11-08-88

FIGURE B64

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator Shaft Displ. IB Brg Hor.
PROCESS CONDITION : Load 0.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 60.1 | 5.92 |
| 2 | 90.2 | 5.60 |
| 3 | 150.3 | 3.30 |
| 4 | 120.3 | 2.32 |
| 5 | 299.5 | 1.66 |
| 6 | 210.5 | 1.45 |
| 7 | 30.1 | 1.40 |
| 8 | 269.4 | 0.90 |
| 9 | 75.8 | 0.88 |
| 10 | 329.5 | 0.86 |

SCALE: Linear

DATE: 11-08-88

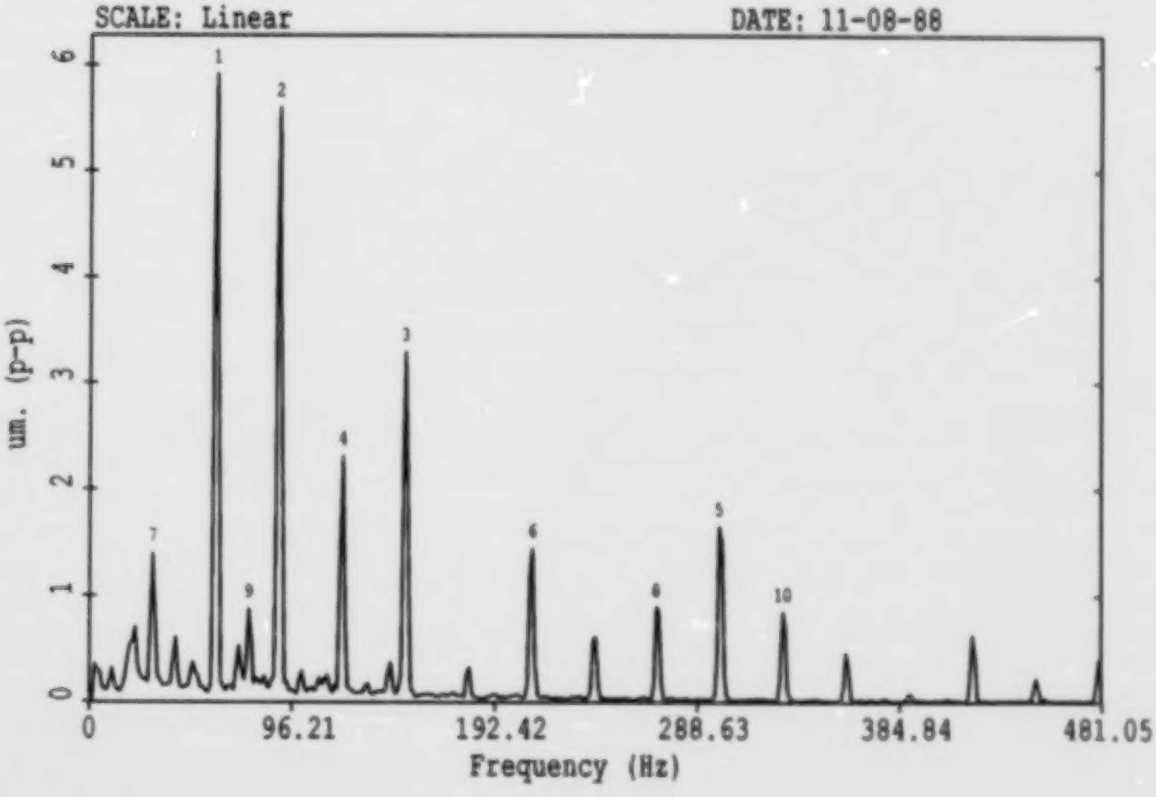


FIGURE B65

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator Shaft Displ. IB Brg Hor.
PROCESS CONDITION : Load 1.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 25.3 | 20.18 |
| 2 | 60.1 | 7.17 |
| 3 | 90.2 | 5.49 |
| 4 | 50.5 | 4.19 |
| 5 | 150.3 | 3.23 |
| 6 | 55.3 | 1.88 |
| 7 | 120.3 | 1.68 |
| 8 | 299.5 | 1.63 |
| 9 | 210.5 | 1.41 |
| 10 | 75.8 | 1.37 |

SCALE: Linear

DATE: 11-08-88

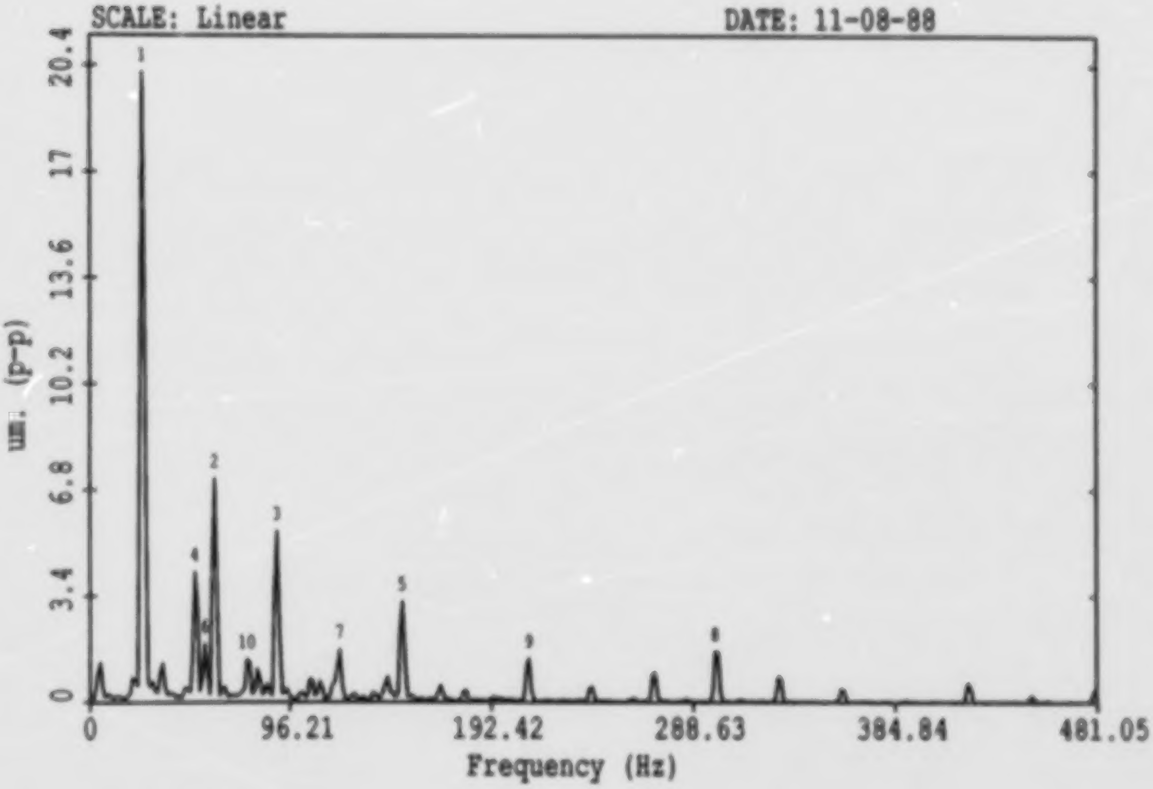


FIGURE B66

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator Shaft Displ. IB Brg Hor.
PROCESS CONDITION : Load 2.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 5.20 |
| 2 | 60.1 | 5.17 |
| 3 | 90.2 | 4.83 |
| 4 | 150.3 | 3.39 |
| 5 | 120.3 | 2.38 |
| 6 | 299.5 | 1.67 |
| 7 | 210.5 | 1.49 |
| 8 | 75.8 | 1.35 |
| 9 | 143.1 | 1.21 |
| 10 | 270.6 | 0.92 |

SCALE: Linear DATE: 11-08-88

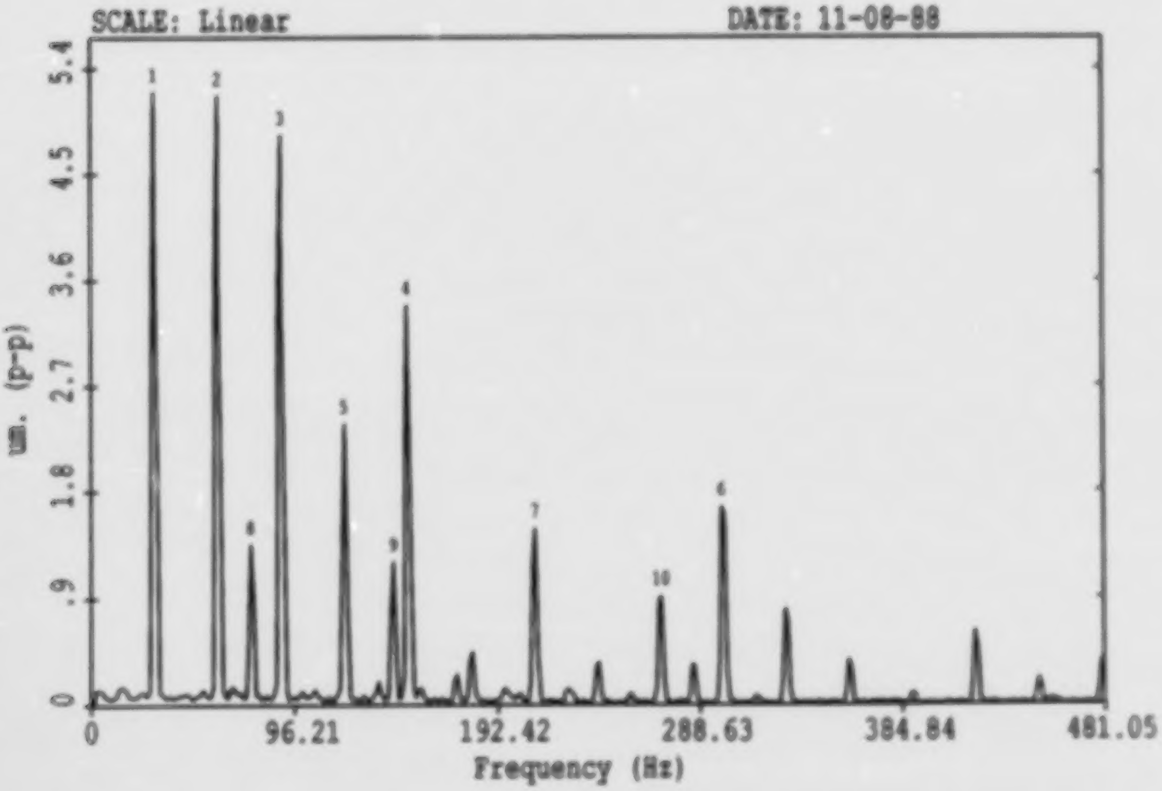


FIGURE B67

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator Shaft Displ. IB Brg Hor.
PROCESS CONDITION : Load 3.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 60.1 | 5.51 |
| 2 | 90.2 | 5.01 |
| 3 | 150.3 | 3.18 |
| 4 | 30.1 | 3.06 |
| 5 | 120.3 | 2.50 |
| 6 | 299.5 | 1.66 |
| 7 | 75.8 | 1.62 |
| 8 | 210.5 | 1.55 |
| 9 | 143.1 | 1.23 |
| 10 | 270.6 | 0.90 |

SCALE: Linear

DATE: 11-08-88

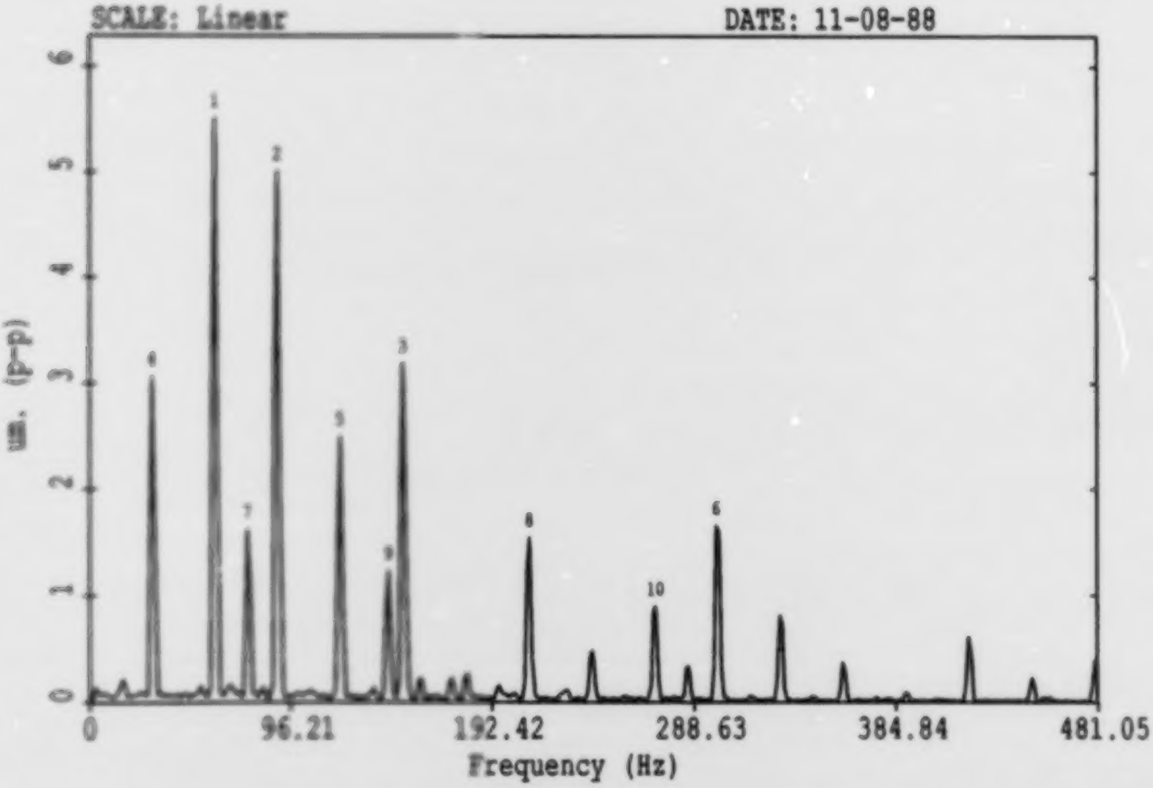


FIGURE B68

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator Shaft Displ. IB Brg Hor.
PROCESS CONDITION : Load 4.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 60.1 | 5.88 |
| 2 | 90.2 | 4.92 |
| 3 | 150.3 | 3.32 |
| 4 | 120.3 | 2.44 |
| 5 | 75.8 | 1.77 |
| 6 | 30.1 | 1.72 |
| 7 | 300.7 | 1.65 |
| 8 | 210.5 | 1.56 |
| 9 | 143.1 | 1.17 |
| 10 | 270.6 | 0.95 |

SCALE: Linear

DATE: 11-08-88

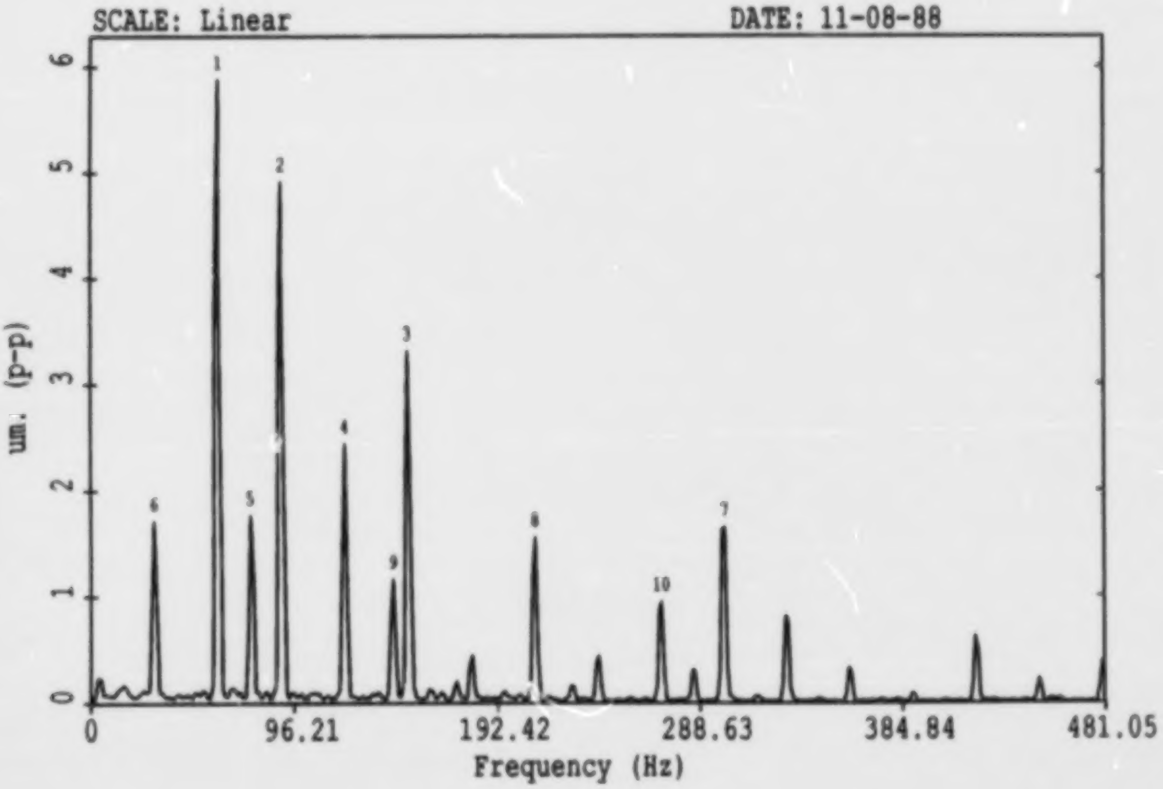


FIGURE B69

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator Shaft Displ. IB Brg Hor.
PROCESS CONDITION : Load 5.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 60.1 | 6.19 |
| 2 | 90.2 | 4.86 |
| 3 | 30.1 | 3.68 |
| 4 | 150.3 | 3.30 |
| 5 | 120.3 | 2.42 |
| 6 | 75.8 | 1.91 |
| 7 | 299.5 | 1.68 |
| 8 | 210.5 | 1.50 |
| 9 | 143.1 | 1.10 |
| 10 | 270.6 | 0.95 |

SCALE: Linear

DATE: 11-08-88

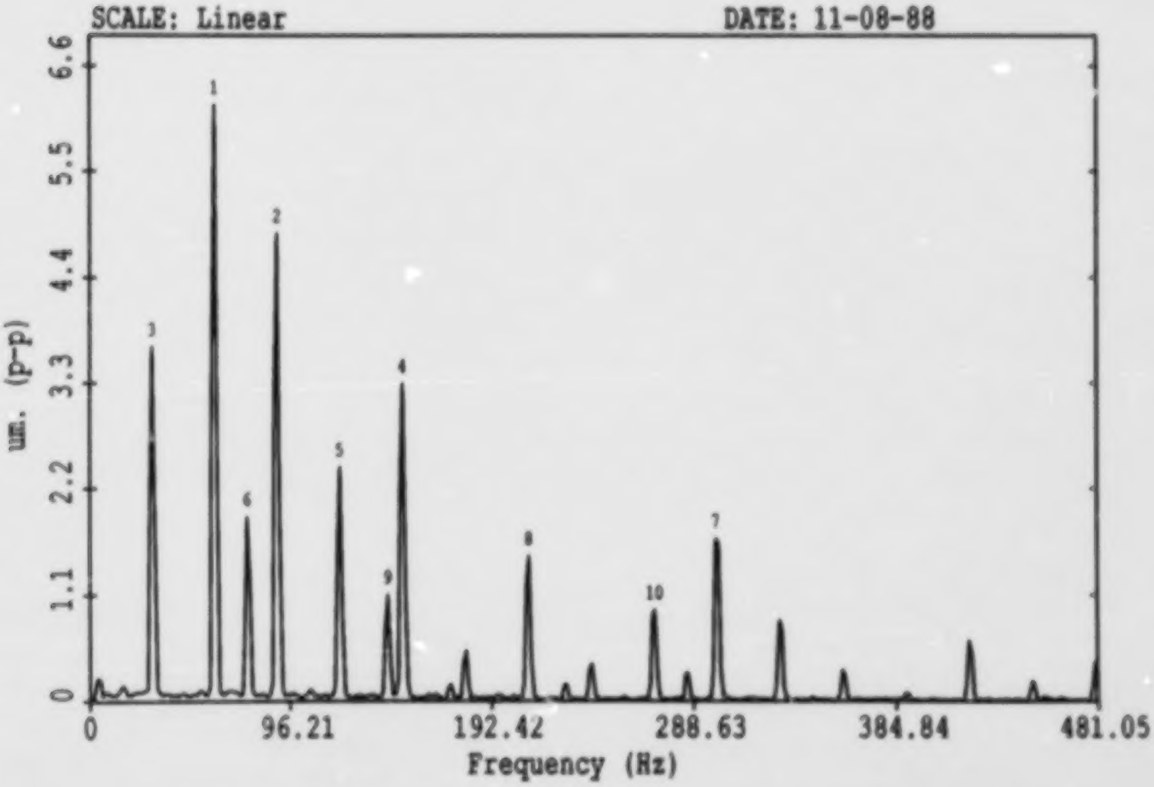


FIGURE B70

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator Shaft Displ. IB Brg Hor.
PROCESS CONDITION : Loao 6.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 60.1 | 6.40 |
| 2 | 30.1 | 5.21 |
| 3 | 90.2 | 4.90 |
| 4 | 150.3 | 3.33 |
| 5 | 120.3 | 2.41 |
| 6 | 75.8 | 2.05 |
| 7 | 299.5 | 1.69 |
| 8 | 210.5 | 1.51 |
| 9 | 143.1 | 1.02 |
| 10 | 270.6 | 0.96 |

SCALE: Linear DATE: 11-08-88

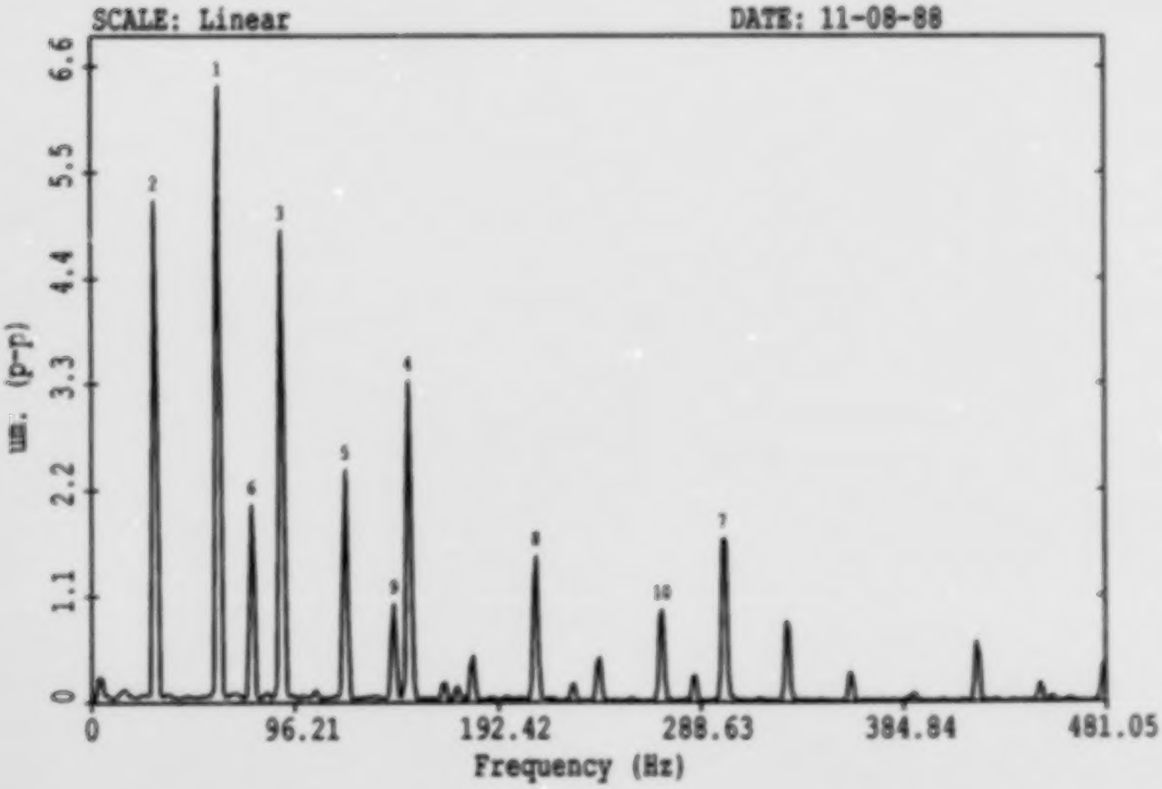


FIGURE B71

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : AC Generator Shaft Displ. IB Brg Hor.
PROCESS CONDITION : Load 6.9 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 7.16 |
| 2 | 60.1 | 6.74 |
| 3 | 90.2 | 4.86 |
| 4 | 150.3 | 3.36 |
| 5 | 120.3 | 2.46 |
| 6 | 75.8 | 2.08 |
| 7 | 300.7 | 1.70 |
| 8 | 210.5 | 1.51 |
| 9 | 270.6 | 0.97 |
| 10 | 143.1 | 0.95 |

SCALE: Linear

DATE: 11-08-88

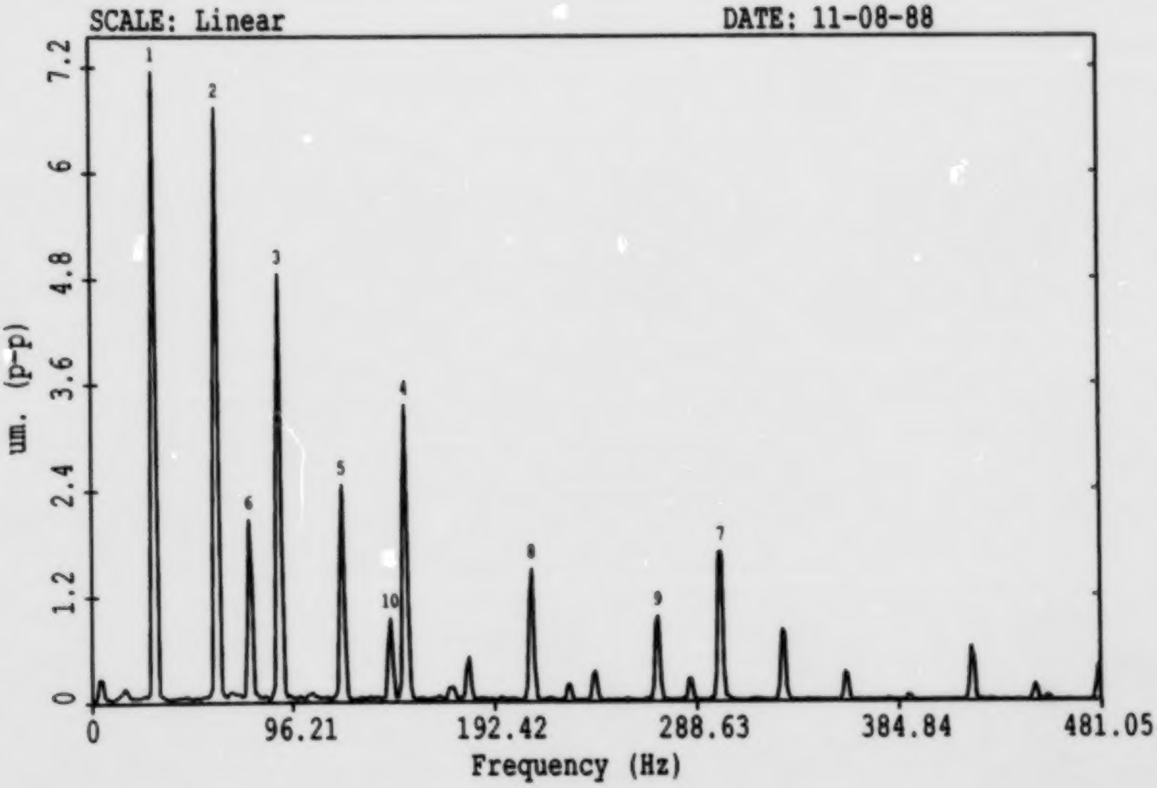


FIGURE B72

# APPENDIX C

# REDUCTION GEARBOX VELOCITY SPECTRA

## TABLE C1
## DARLINGTON NGS 'A' EMERGENCY POWER GENERATOR #1 - REDUCTION GEARBOX
## FIGURE NUMBERS OF VELOCITY SPECTRA

| Measurement | | FFT Spectrum Figure No. Load (MW) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 6.9 |
| **Reduction Gearbox Casing Velocity** | Vertical Direction | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 |
| | Horizontal Direction | C9 | C10 | C11 | C12 | C13 | C14 | C15 | C16 |
| | Axial Direction | C17 | C18 | C19 | C20 | C21 | C22 | C23 | C24 |

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Reduction Gear Box Casing Velocity Vert.
PROCESS CONDITION : Load 0.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 75.8 | 0.41 |
| 2 | 143.1 | 0.37 |
| 3 | 120.3 | 0.35 |
| 4 | 30.1 | 0.33 |
| 5 | 60.1 | 0.31 |
| 6 | 132.3 | 0.28 |
| 7 | 101.0 | 0.26 |
| 8 | 150.3 | 0.26 |
| 9 | 285.0 | 0.21 |
| 10 | 113.0 | 0.21 |

SCALE: Linear

DATE: 11-08-88

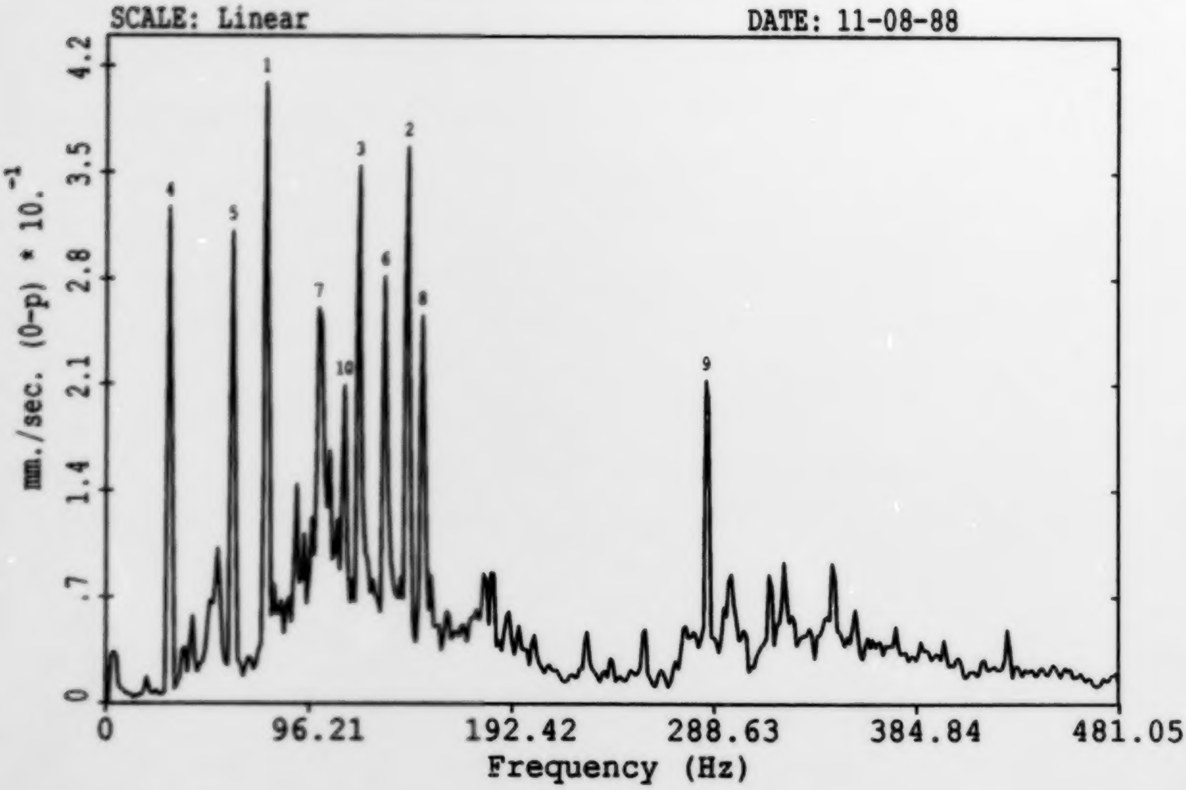


FIGURE C1

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Reduction Gear Box Casing Velocity Vert.
PROCESS CONDITION : Load 1.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 120.3 | 0.46 |
| 2 | 102.2 | 0.45 |
| 3 | 143.1 | 0.42 |
| 4 | 50.5 | 0.40 |
| 5 | 75.8 | 0.40 |
| 6 | 80.6 | 0.38 |
| 7 | 30.1 | 0.27 |
| 8 | 105.8 | 0.26 |
| 9 | 90.2 | 0.24 |
| 10 | 85.4 | 0.20 |

SCALE: Linear DATE: 11-08-88

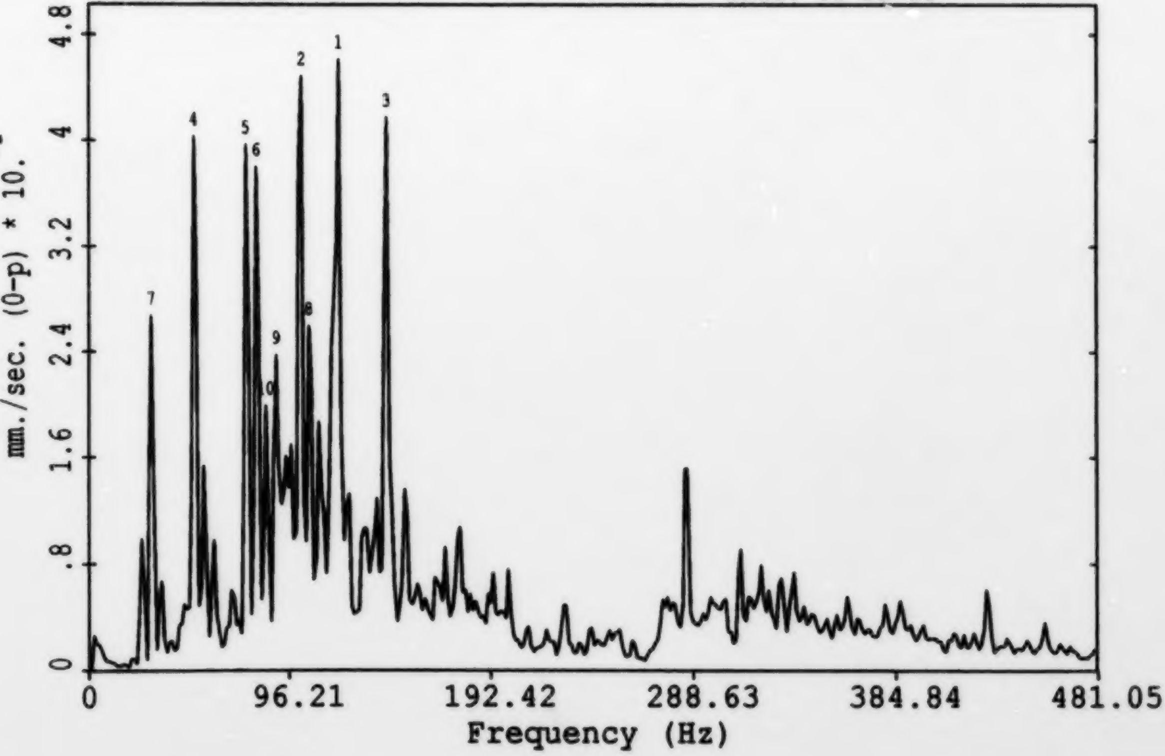


FIGURE C2

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Reduction Gear Box Casing Velocity Vert.
PROCESS CONDITION : Load 2.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 90.2 | 0.65 |
| 2 | 143.1 | 0.57 |
| 3 | 30.1 | 0.48 |
| 4 | 120.3 | 0.45 |
| 5 | 60.1 | 0.37 |
| 6 | 75.8 | 0.31 |
| 7 | 285.0 | 0.23 |
| 8 | 113.0 | 0.16 |
| 9 | 151.5 | 0.13 |
| 10 | 83.0 | 0.11 |

SCALE: Linear DATE: 11-08-88

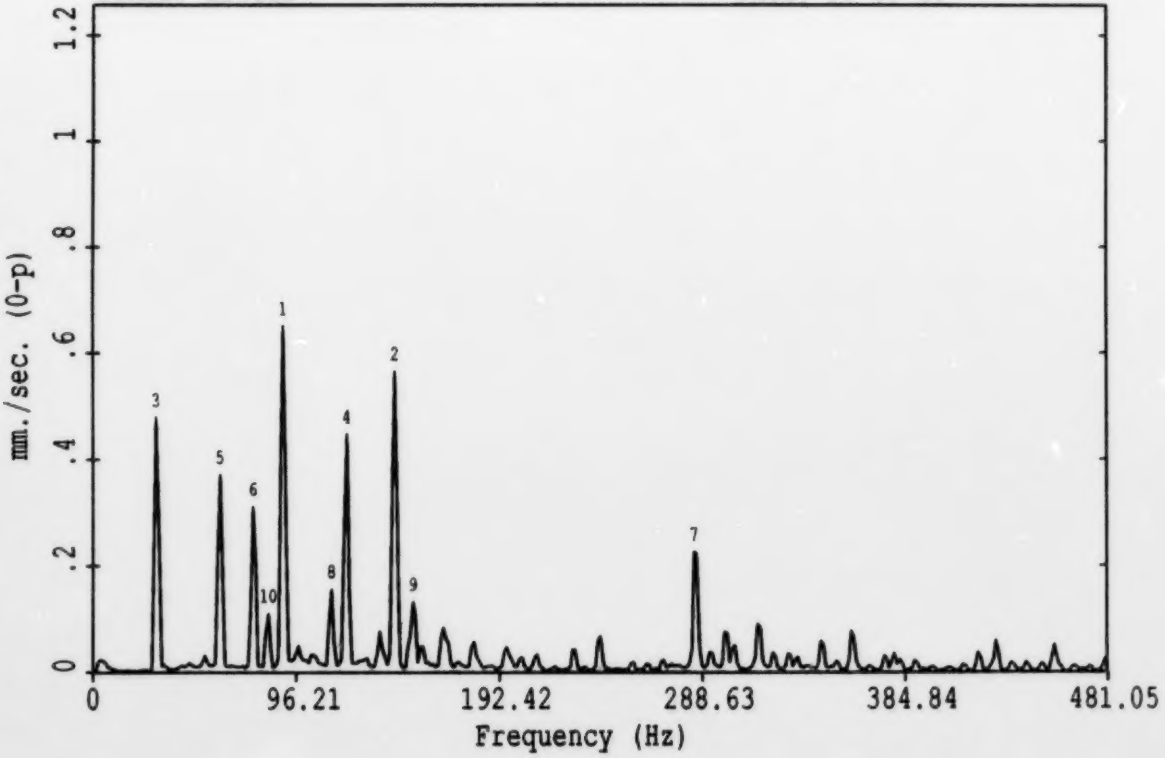


FIGURE C3

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Reduction Gear Box Casing Velocity Vert.
PROCESS CONDITION : Load 3.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 120.3 | 0.64 |
| 2 | 90.2 | 0.52 |
| 3 | 143.1 | 0.46 |
| 4 | 30.1 | 0.36 |
| 5 | 60.1 | 0.32 |
| 6 | 75.8 | 0.30 |
| 7 | 113.0 | 0.15 |
| 8 | 151.5 | 0.14 |
| 9 | 83.0 | 0.11 |
| 10 | 105.8 | 0.09 |

SCALE: Linear

DATE: 11-08-88

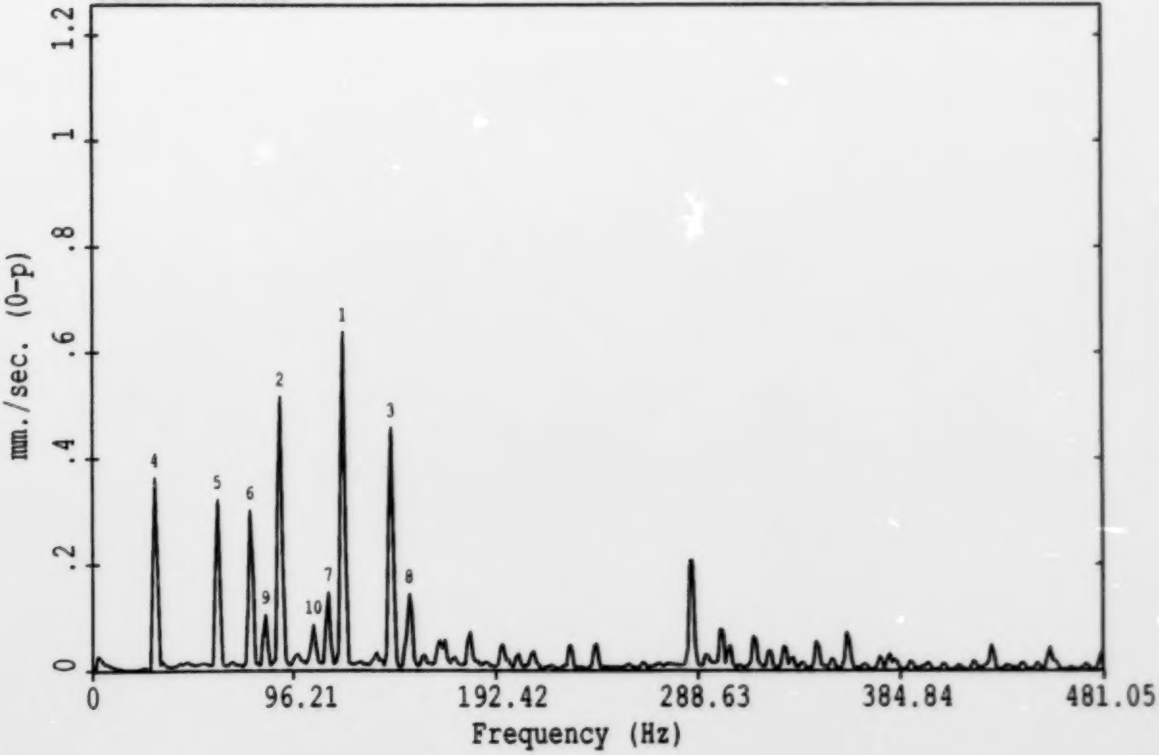


FIGURE C4

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Reduction Gear Box Casing Velocity Vert.
PROCESS CONDITION : Load 4.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 120.3 | 0.76 |
| 2 | 143.1 | 0.49 |
| 3 | 90.2 | 0.32 |
| 4 | 30.1 | 0.31 |
| 5 | 75.8 | 0.26 |
| 6 | 60.1 | 0.21 |
| 7 | 286.2 | 0.19 |
| 8 | 151.5 | 0.17 |
| 9 | 180.4 | 0.09 |
| 10 | 359.6 | 0.08 |

SCALE: Linear

DATE: 11-08-88

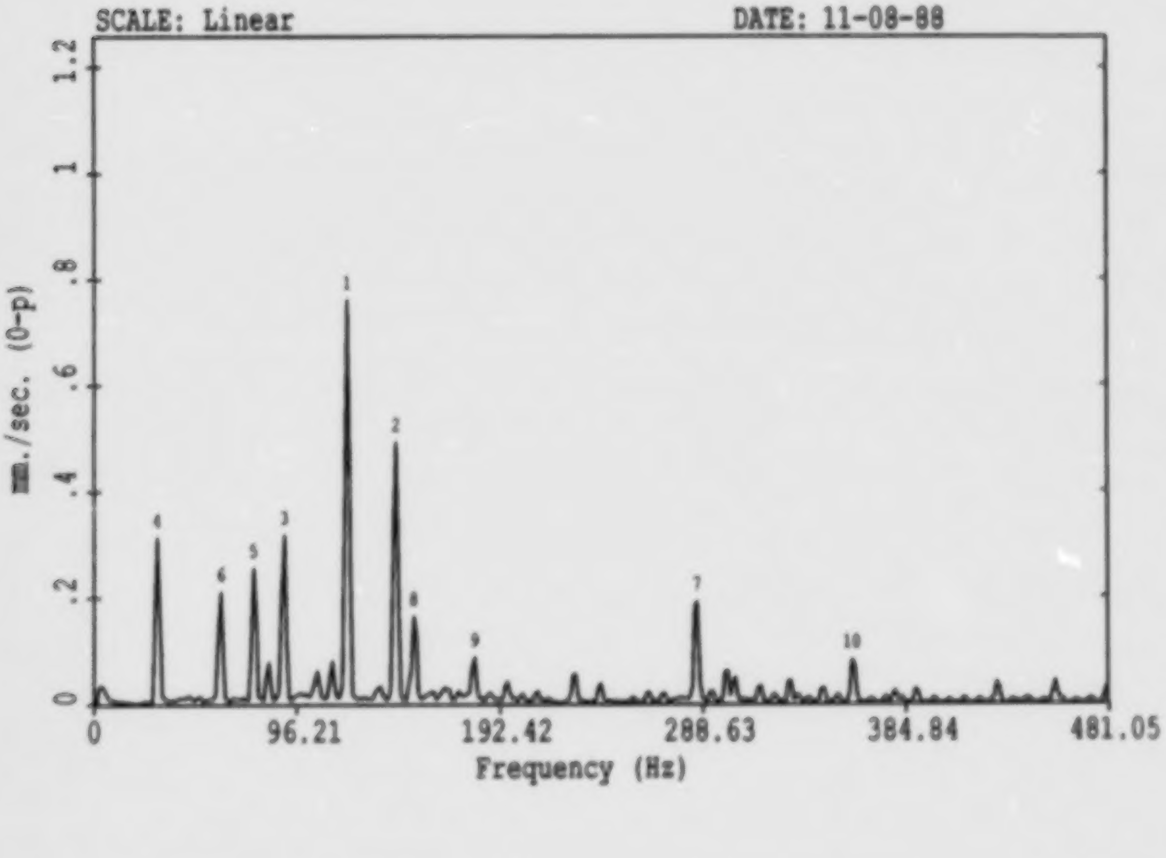


FIGURE C5

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Reduction Gear Box Casing Velocity Vert.
PROCESS CONDITION : Load 5.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 120.3 | 0.86 |
| 2 | 143.1 | 0.58 |
| 3 | 30.1 | 0.31 |
| 4 | 75.8 | 0.24 |
| 5 | 90.2 | 0.23 |
| 6 | 60.1 | 0.21 |
| 7 | 286.2 | 0.20 |
| 8 | 151.5 | 0.19 |
| 9 | 359.6 | 0.09 |
| 10 | 180.4 | 0.08 |

SCALE: Linear

DATE: 11-08-88

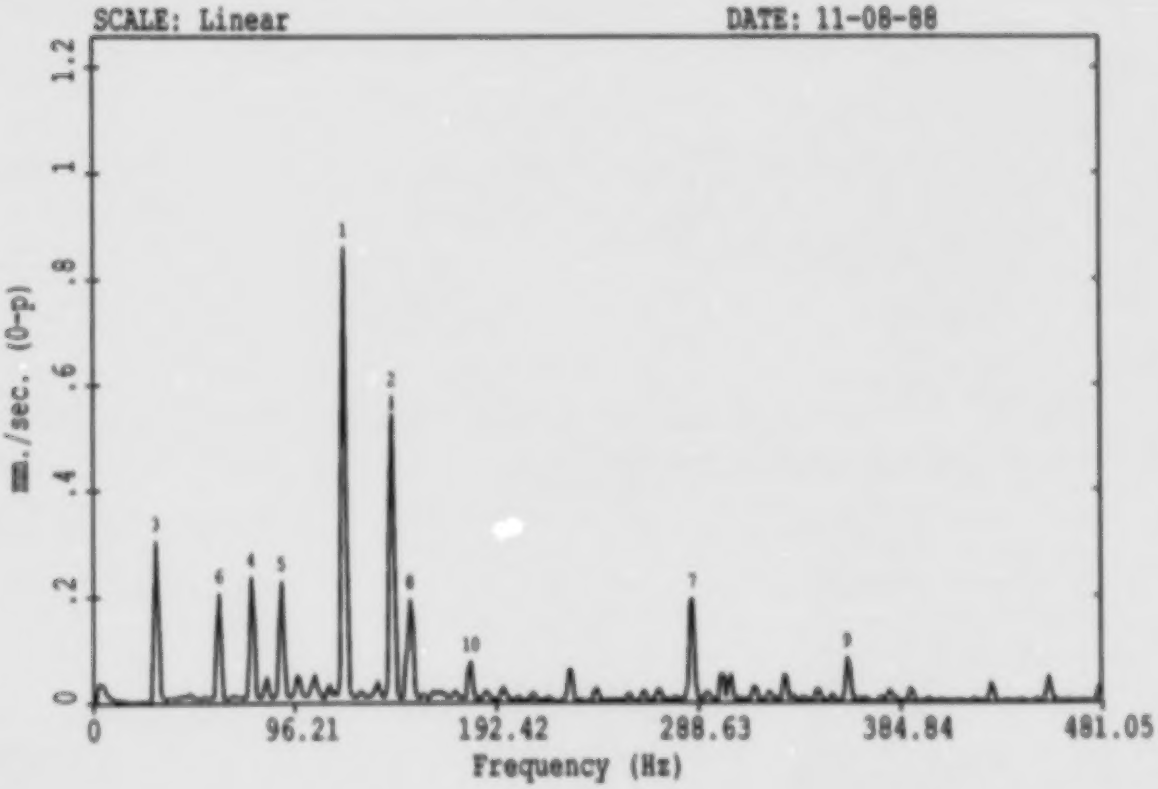


FIGURE C6

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Reduction Gear Box Casing Velocity Vert.
PROCESS CONDITION : Load 6.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 120.3 | 0.87 |
| 2 | 143.1 | 0.63 |
| 3 | 30.1 | 0.29 |
| 4 | 75.8 | 0.22 |
| 5 | 151.5 | 0.21 |
| 6 | 60.1 | 0.20 |
| 7 | 286.2 | 0.20 |
| 8 | 90.2 | 0.19 |
| 9 | 180.4 | 0.10 |
| 10 | 359.6 | 0.09 |

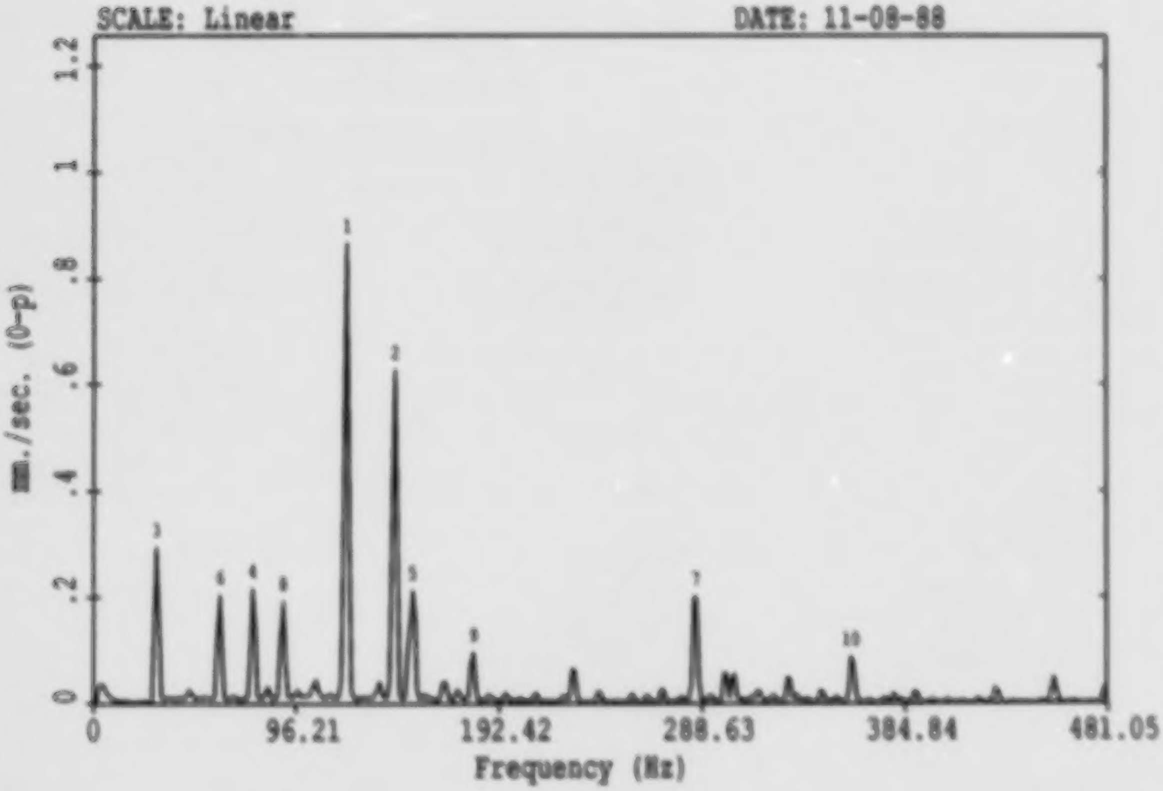


FIGURE C7

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Reduction Gear Box Casing Velocity Vert.
PROCESS CONDITION : Load 6.9 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 120.3 | 0.87 |
| 2 | 143.1 | 0.63 |
| 3 | 30.1 | 0.31 |
| 4 | 286.2 | 0.24 |
| 5 | 75.8 | 0.22 |
| 6 | 151.5 | 0.21 |
| 7 | 60.1 | 0.18 |
| 8 | 90.2 | 0.15 |
| 9 | 359.6 | 0.10 |
| 10 | 180.4 | 0.09 |

SCALE: Linear

DATE: 11-08-88

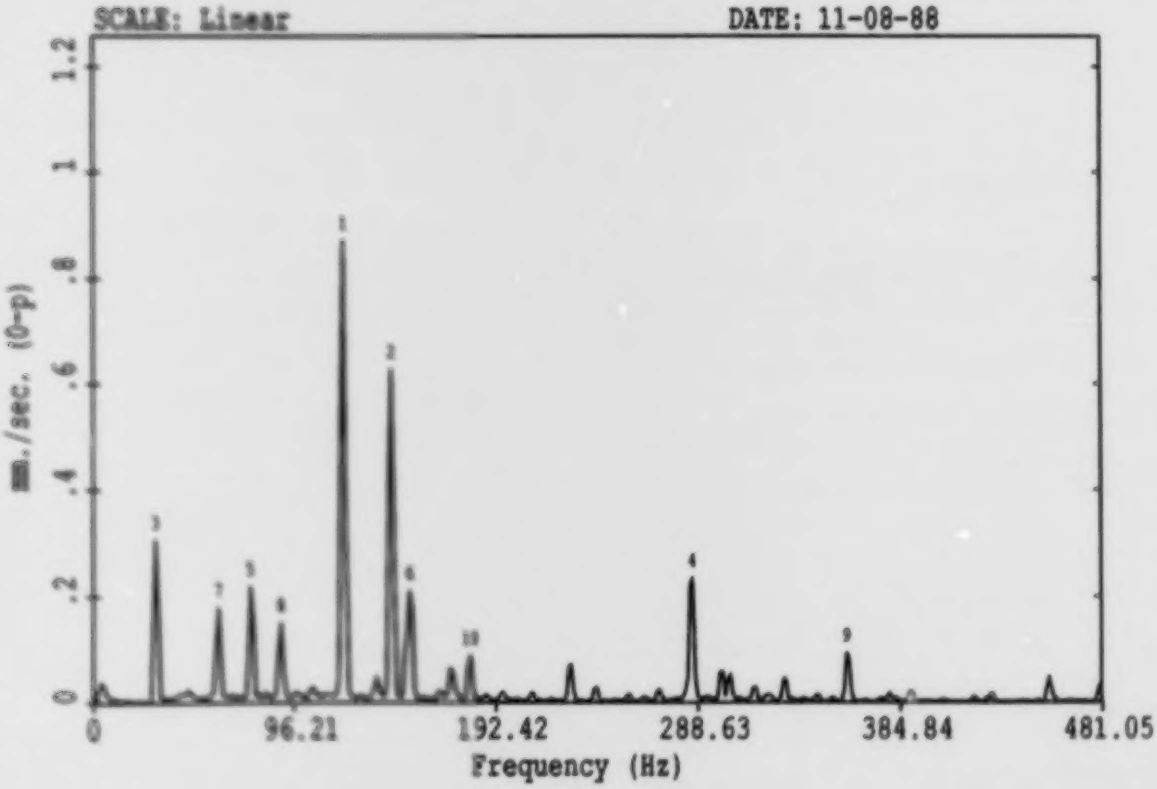


FIGURE C8

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Reduction Gear Box Casing Velocity Hor.
PROCESS CONDITION : Load 0.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 75.8 | 1.16 |
| 2 | 143.1 | 1.02 |
| 3 | 30.1 | 0.97 |
| 4 | 60.1 | 0.65 |
| 5 | 120.3 | 0.55 |
| 6 | 153.9 | 0.39 |
| 7 | 132.3 | 0.32 |
| 8 | 109.4 | 0.25 |
| 9 | 150.3 | 0.24 |
| 10 | 163.6 | 0.15 |

SCALE: Linear DATE: 11-08-88

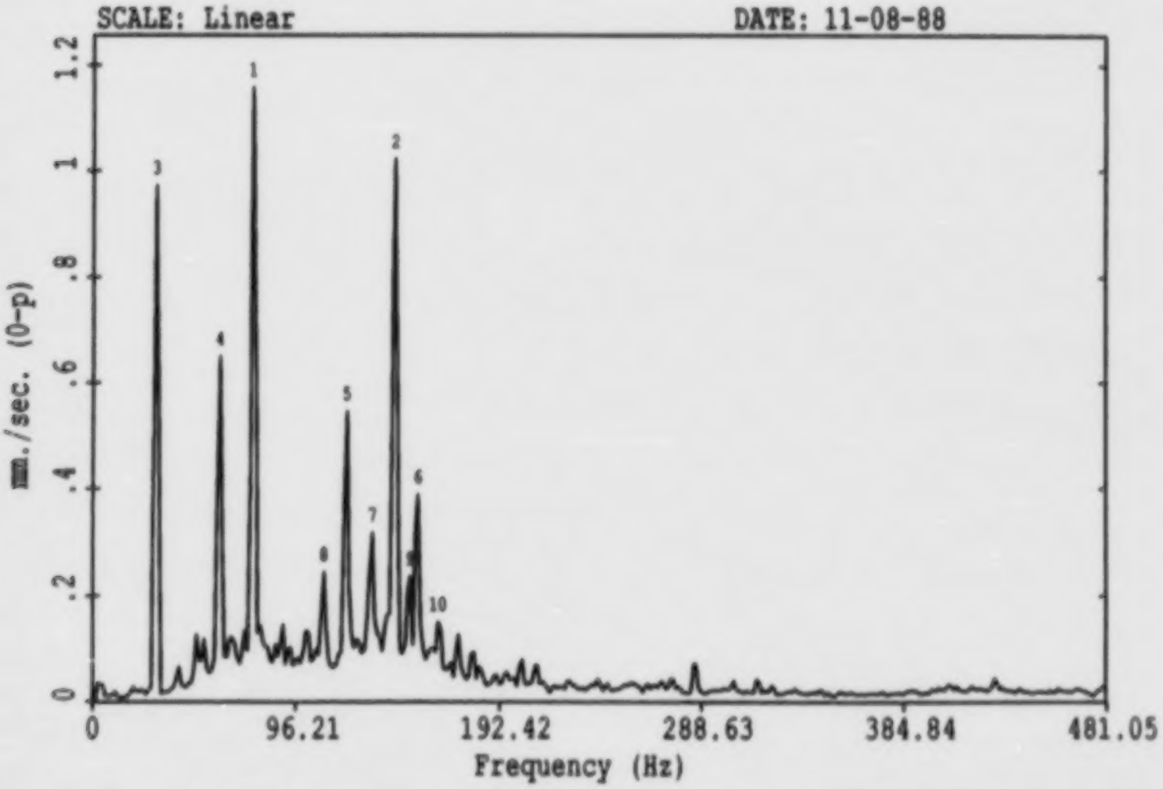


FIGURE C9

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Reduction Gear Box Casing Velocity Hor.
PROCESS CONDITION : Load 1.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 143.1 | 1.54 |
| 2 | 25.3 | 1.05 |
| 3 | 75.8 | 0.89 |
| 4 | 30.1 | 0.80 |
| 5 | 120.3 | 0.79 |
| 6 | 55.3 | 0.61 |
| 7 | 50.5 | 0.58 |
| 8 | 168.4 | 0.50 |
| 9 | 80.6 | 0.44 |
| 10 | 60.1 | 0.40 |

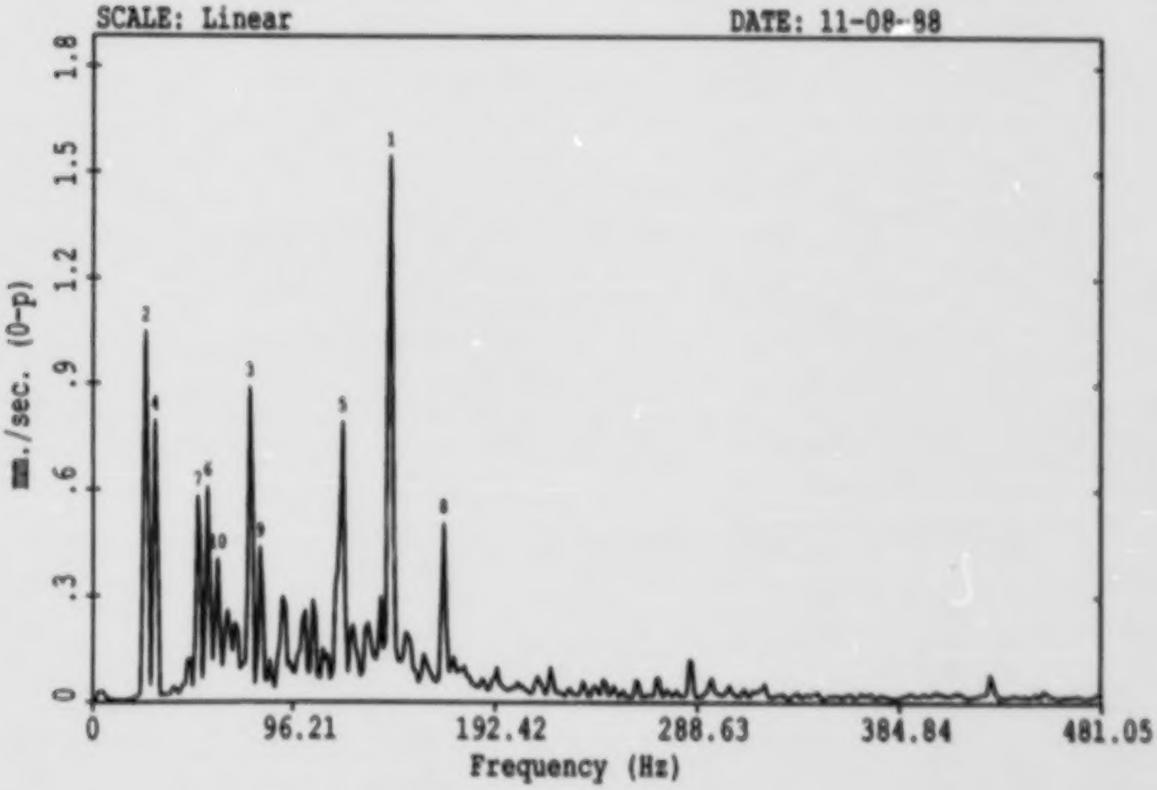


FIGURE C10

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Reduction Gear Box Casing Velocity Hor.
PROCESS CONDITION : Load 2.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 143.1 | 2.60 |
| 2 | 75.8 | 1.09 |
| 3 | 30.1 | 1.06 |
| 4 | 120.3 | 0.67 |
| 5 | 60.1 | 0.64 |
| 6 | 150.3 | 0.57 |
| 7 | 173.2 | 0.22 |
| 8 | 135.9 | 0.19 |
| 9 | 286.2 | 0.14 |
| 10 | 90.2 | 0.13 |

SCALE: Linear

DATE: 11-08-88

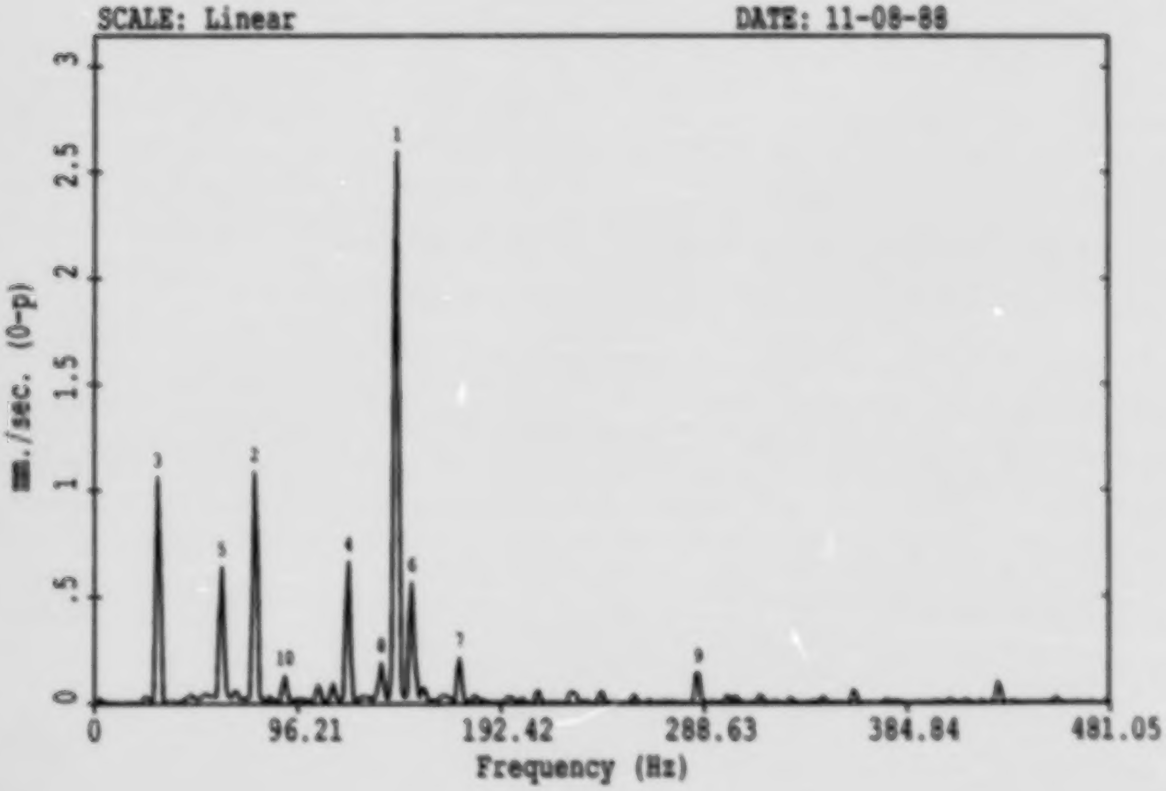
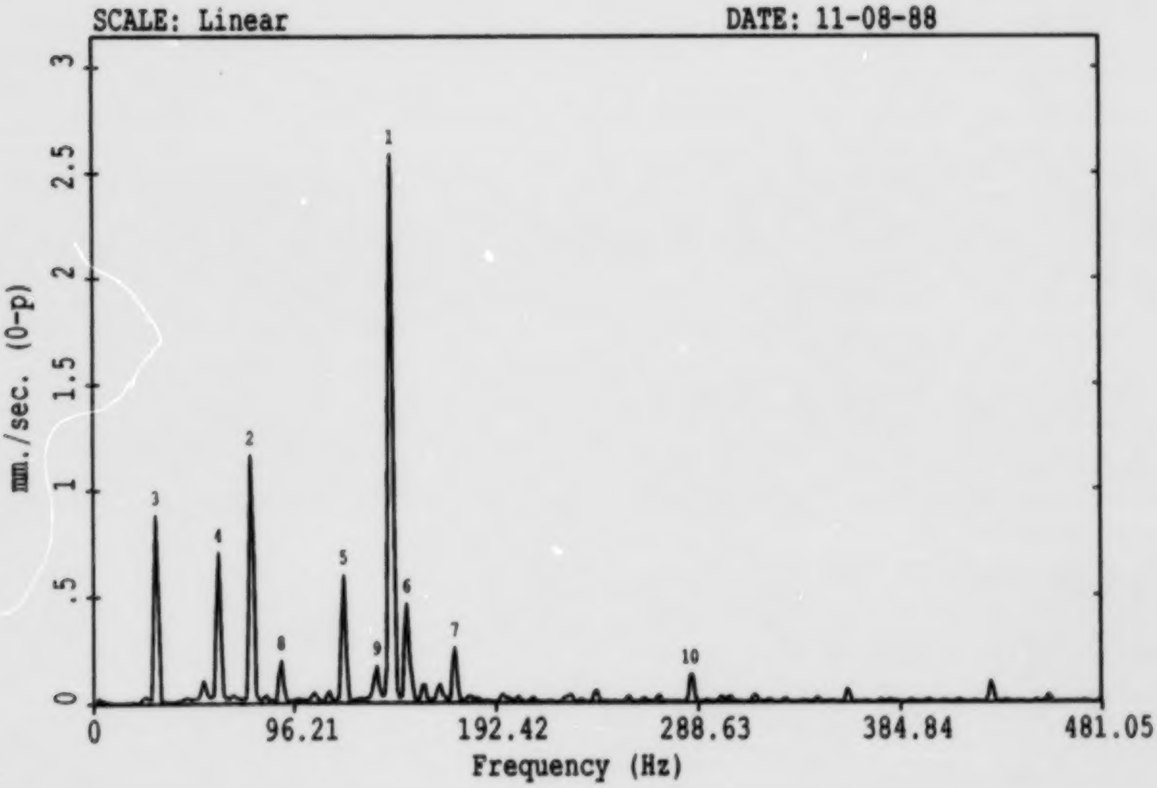


FIGURE C11

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Reduction Gear Box Casing Velocity Hor.
PROCESS CONDITION : Load 3.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 143.1 | 2.59 |
| 2 | 75.8 | 1.16 |
| 3 | 30.1 | 0.89 |
| 4 | 60.1 | 0.71 |
| 5 | 120.3 | 0.60 |
| 6 | 150.3 | 0.46 |
| 7 | 173.2 | 0.26 |
| 8 | 90.2 | 0.20 |
| 9 | 135.9 | 0.17 |
| 10 | 285.0 | 0.13 |


SCALE: Linear

DATE: 11-08-88

FIGURE C12

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Reduction Gear Box Casing Velocity Hor.
PROCESS CONDITION : Load 4.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 143.1 | 2.44 |
| 2 | 75.8 | 1.24 |
| 3 | 30.1 | 0.85 |
| 4 | 120.3 | 0.77 |
| 5 | 60.1 | 0.54 |
| 6 | 150.3 | 0.44 |
| 7 | 173.2 | 0.19 |
| 8 | 135.9 | 0.14 |
| 9 | 286.2 | 0.13 |
| 10 | 428.1 | 0.10 |

SCALE: Linear

DATE: 11-08-88

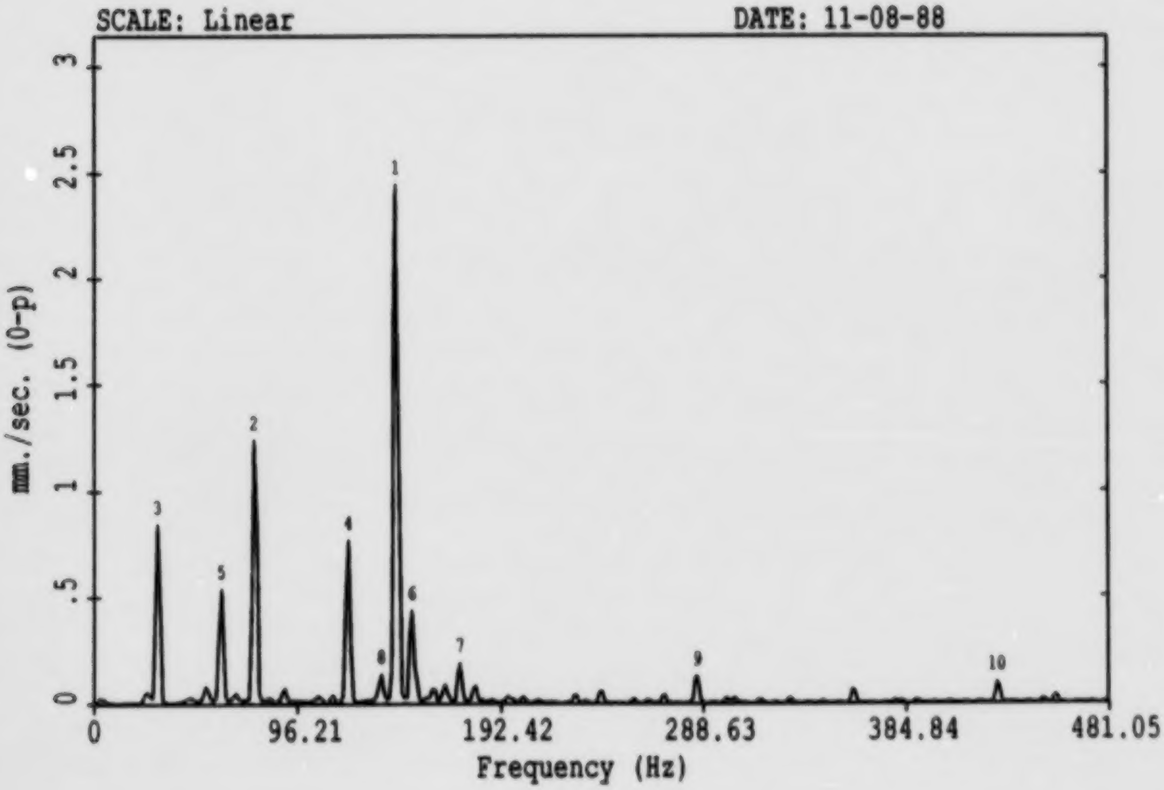


FIGURE C13

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Reduction Gear Box Casing Velocity Hor.
PROCESS CONDITION : Load 5.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 143.1 | 2.32 |
| 2 | 75.8 | 1.31 |
| 3 | 30.1 | 0.93 |
| 4 | 120.3 | 0.84 |
| 5 | 60.1 | 0.46 |
| 6 | 150.3 | 0.37 |
| 7 | 173.2 | 0.13 |
| 8 | 286.2 | 0.13 |
| 9 | 135.9 | 0.11 |
| 10 | 428.1 | 0.10 |

SCALE: Linear

DATE: 11-08-88

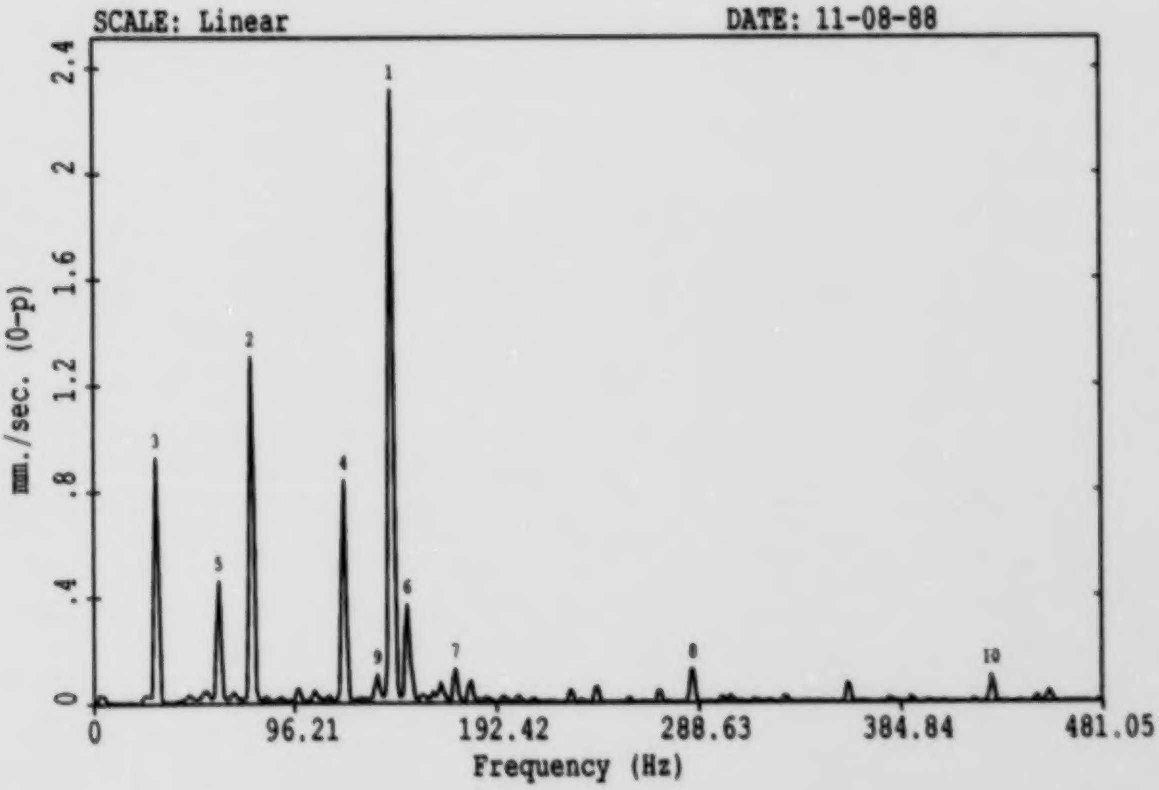


FIGURE C14

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Reduction Gear Box Casing Velocity Hor.
PROCESS CONDITION : Load 6.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 143.1 | 2.24 |
| 2 | 75.8 | 1.38 |
| 3 | 30.1 | 0.95 |
| 4 | 120.3 | 0.93 |
| 5 | 60.1 | 0.42 |
| 6 | 150.3 | 0.34 |
| 7 | 286.2 | 0.12 |
| 8 | 166.0 | 0.10 |
| 9 | 135.9 | 0.10 |
| 10 | 428.1 | 0.09 |

SCALE: Linear

DATE: 11-08-88

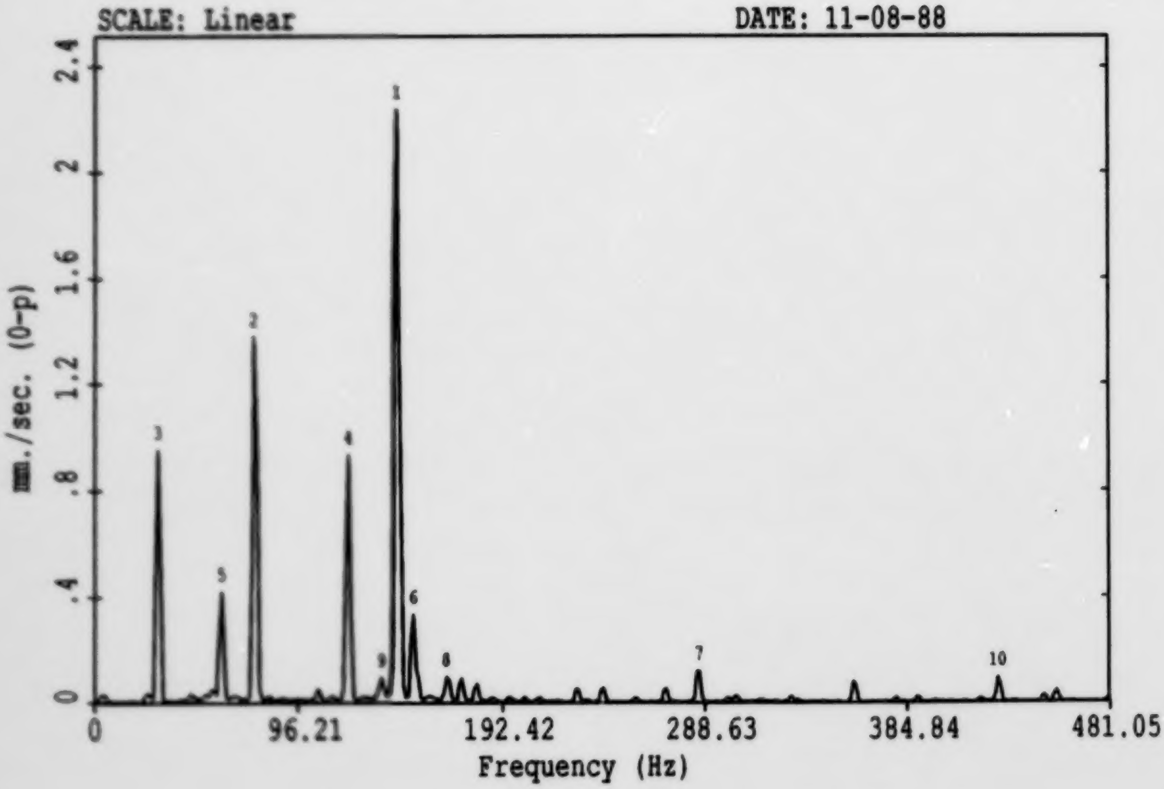


FIGURE C15

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Reduction Gear Box Casing Velocity Hor.
PROCESS CONDITION : Load 6.9 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 143.1 | 2.29 |
| 2 | 75.8 | 1.41 |
| 3 | 30.1 | 1.05 |
| 4 | 120.3 | 0.96 |
| 5 | 60.1 | 0.38 |
| 6 | 150.3 | 0.36 |
| 7 | 286.2 | 0.12 |
| 8 | 172.0 | 0.10 |
| 9 | 135.9 | 0.10 |
| 10 | 428.1 | 0.09 |

SCALE: Linear

DATE: 11-08-88

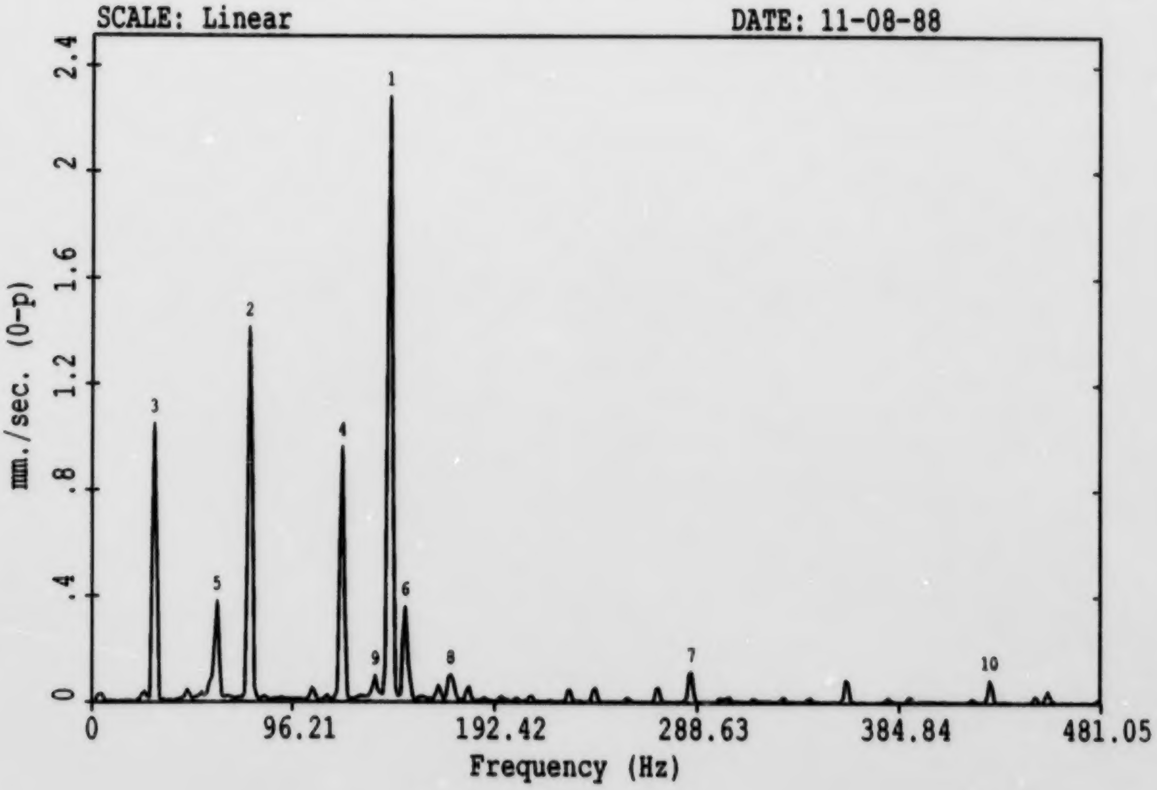


FIGURE C16

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Reduction Gear Box Casing Velocity Axial
PROCESS CONDITION : Load 0.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 60.1 | 0.46 |
| 2 | 30.1 | 0.38 |
| 3 | 90.2 | 0.38 |
| 4 | 75.8 | 0.33 |
| 5 | 71.0 | 0.27 |
| 6 | 143.1 | 0.26 |
| 7 | 52.9 | 0.23 |
| 8 | 49.3 | 0.22 |
| 9 | 120.3 | 0.21 |
| 10 | 101.0 | 0.15 |

SCALE: Linear DATE: 11-08-88

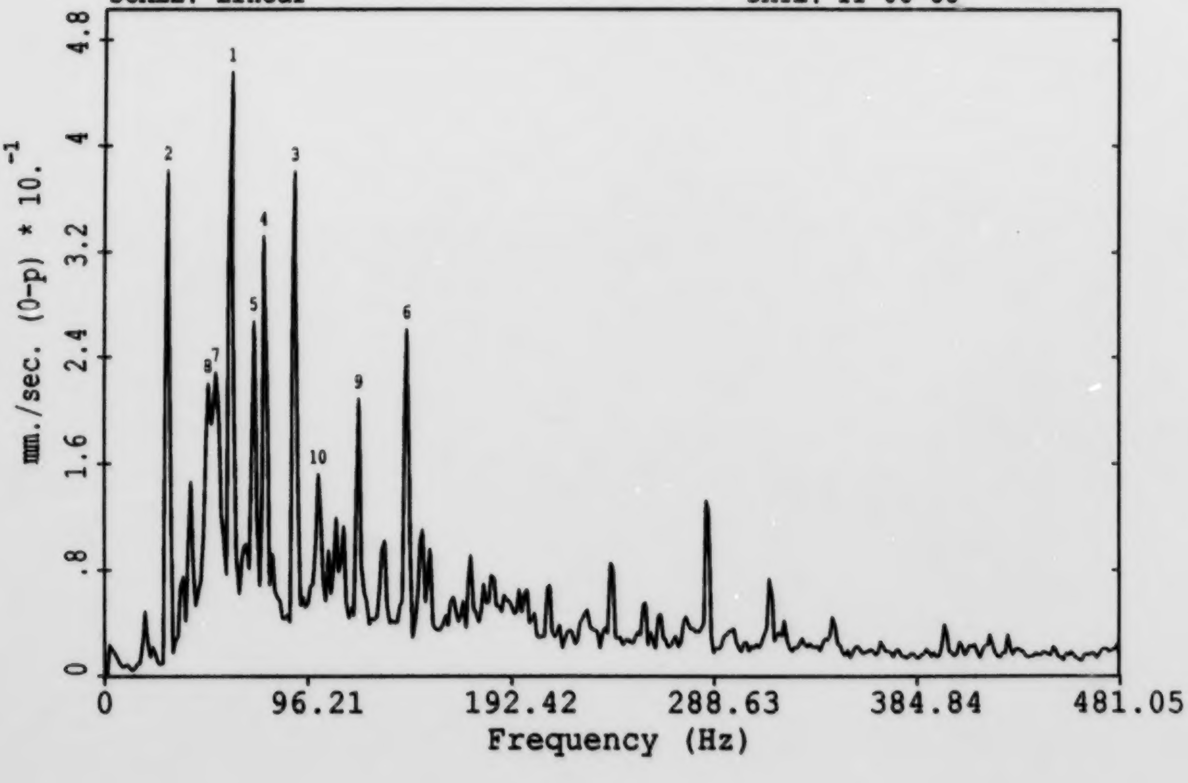


FIGURE C17

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Reduction Gear Box Casing Velocity Axial
PROCESS CONDITION : Load 1.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 50.5 | 1.13 |
| 2 | 55.3 | 0.85 |
| 3 | 25.3 | 0.54 |
| 4 | 60.1 | 0.51 |
| 5 | 80.6 | 0.30 |
| 6 | 75.8 | 0.30 |
| 7 | 45.7 | 0.24 |
| 8 | 64.9 | 0.24 |
| 9 | 120.3 | 0.22 |
| 10 | 168.4 | 0.20 |

SCALE: Linear

DATE: 11-08-88

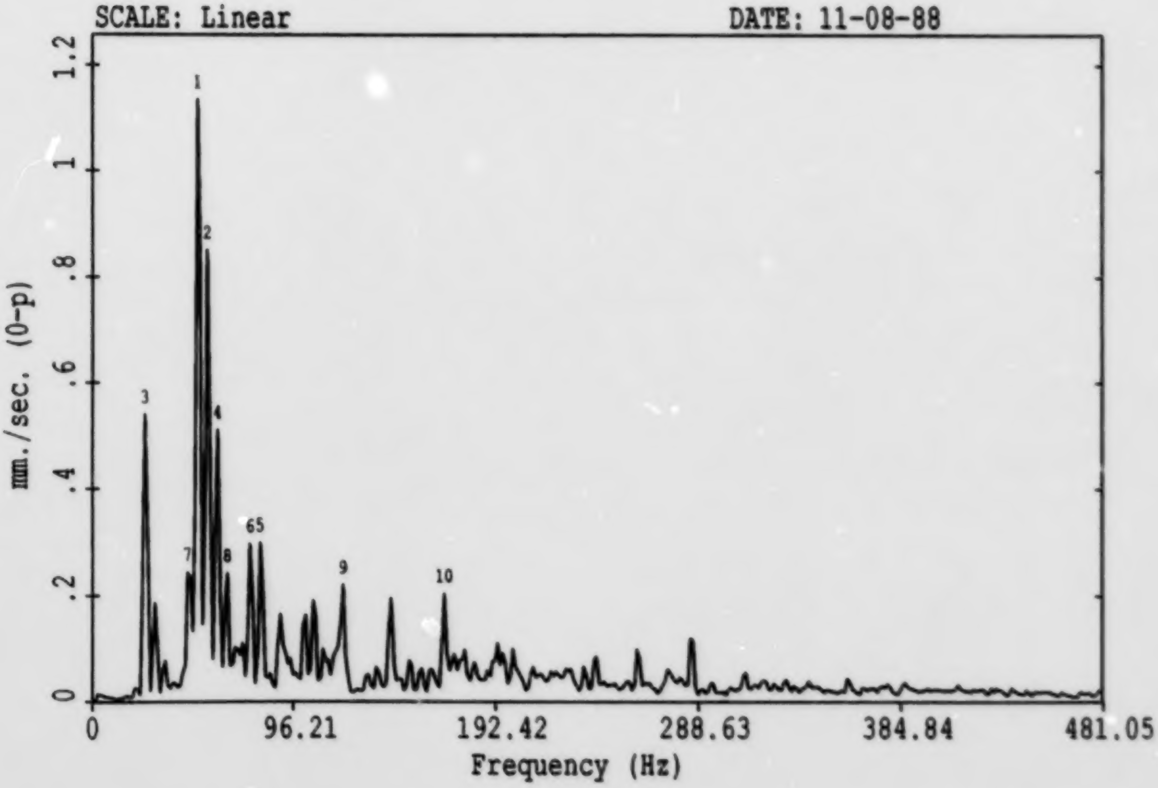


FIGURE C18

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Reduction Gear Box Casing Velocity Axial
PROCESS CONDITION : Load 2.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 60.1 | 1.14 |
| 2 | 30.1 | 0.58 |
| 3 | 90.2 | 0.41 |
| 4 | 75.8 | 0.24 |
| 5 | 120.3 | 0.18 |
| 6 | 240.5 | 0.12 |
| 7 | 180.4 | 0.10 |
| 8 | 45.7 | 0.09 |
| 9 | 83.0 | 0.09 |
| 10 | 143.1 | 0.09 |

SCALE: Linear

DATE: 11-08-88

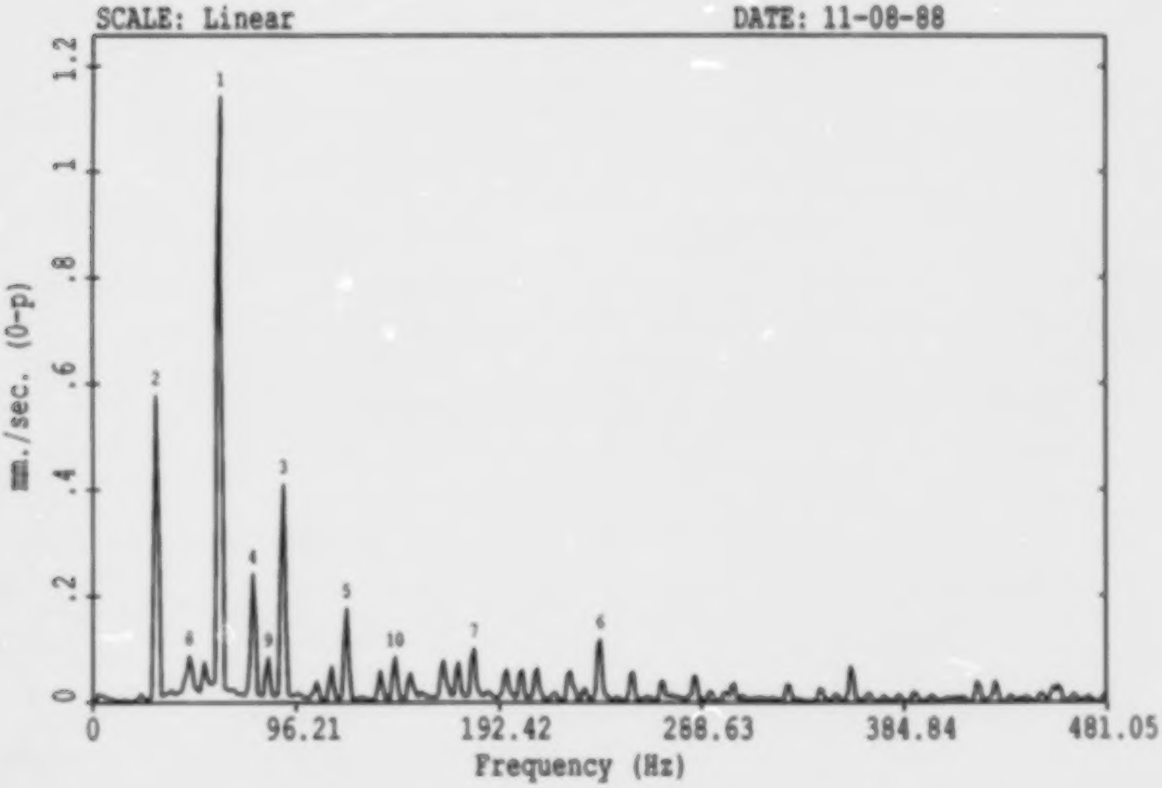


FIGURE C19

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Reduction Gear Box Casing Velocity Axial
PROCESS CONDITION : Load 3.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 60.1 | 0.93 |
| 2 | 90.2 | 0.28 |
| 3 | 75.8 | 0.27 |
| 4 | 30.1 | 0.24 |
| 5 | 120.3 | 0.20 |
| 6 | 52.9 | 0.13 |
| 7 | 180.4 | 0.11 |
| 8 | 83.0 | 0.09 |
| 9 | 143.1 | 0.09 |
| 10 | 359.6 | 0.08 |

SCALE: Linear

DATE: 11-08-88

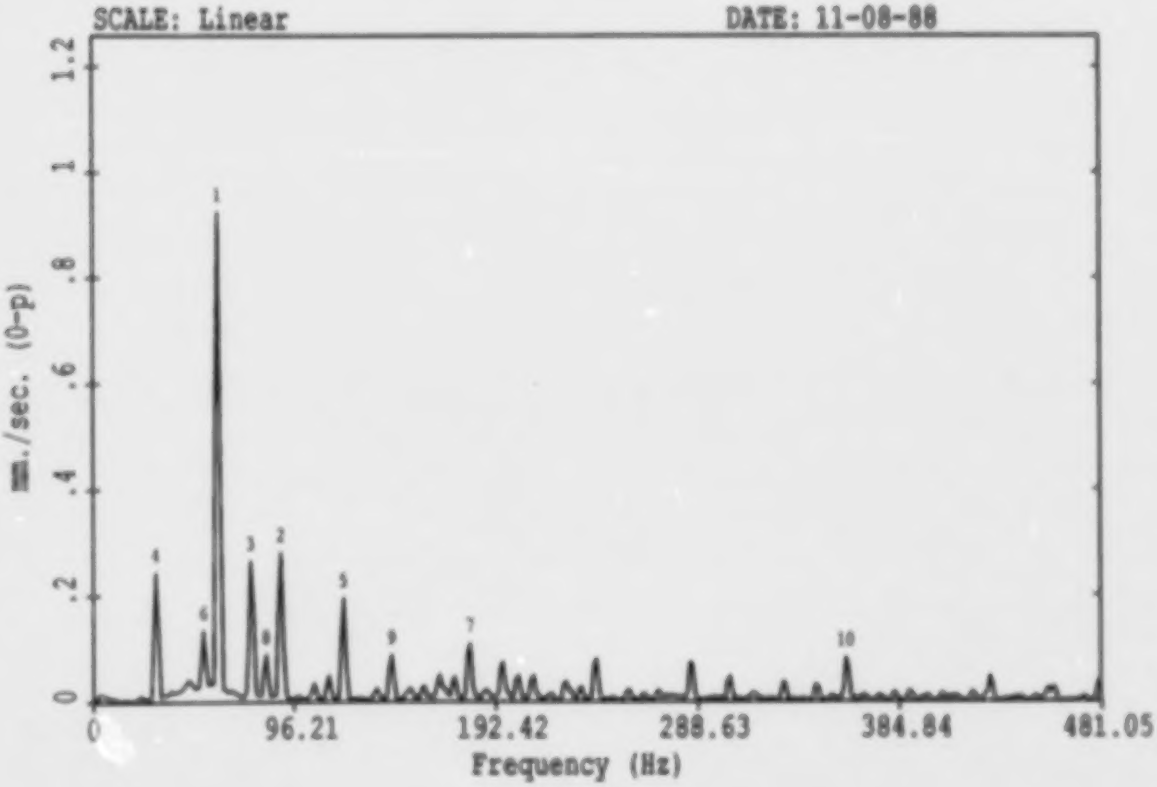


FIGURE C20

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Reduction Gear Box Casing Velocity Axial
PROCESS CONDITION : Load 4.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 60.1 | 0.41 |
| 2 | 75.8 | 0.35 |
| 3 | 120.3 | 0.23 |
| 4 | 30.1 | 0.23 |
| 5 | 90.2 | 0.18 |
| 6 | 143.1 | 0.15 |
| 7 | 286.2 | 0.11 |
| 8 | 180.4 | 0.09 |
| 9 | 359.6 | 0.09 |
| 10 | 83.0 | 0.07 |

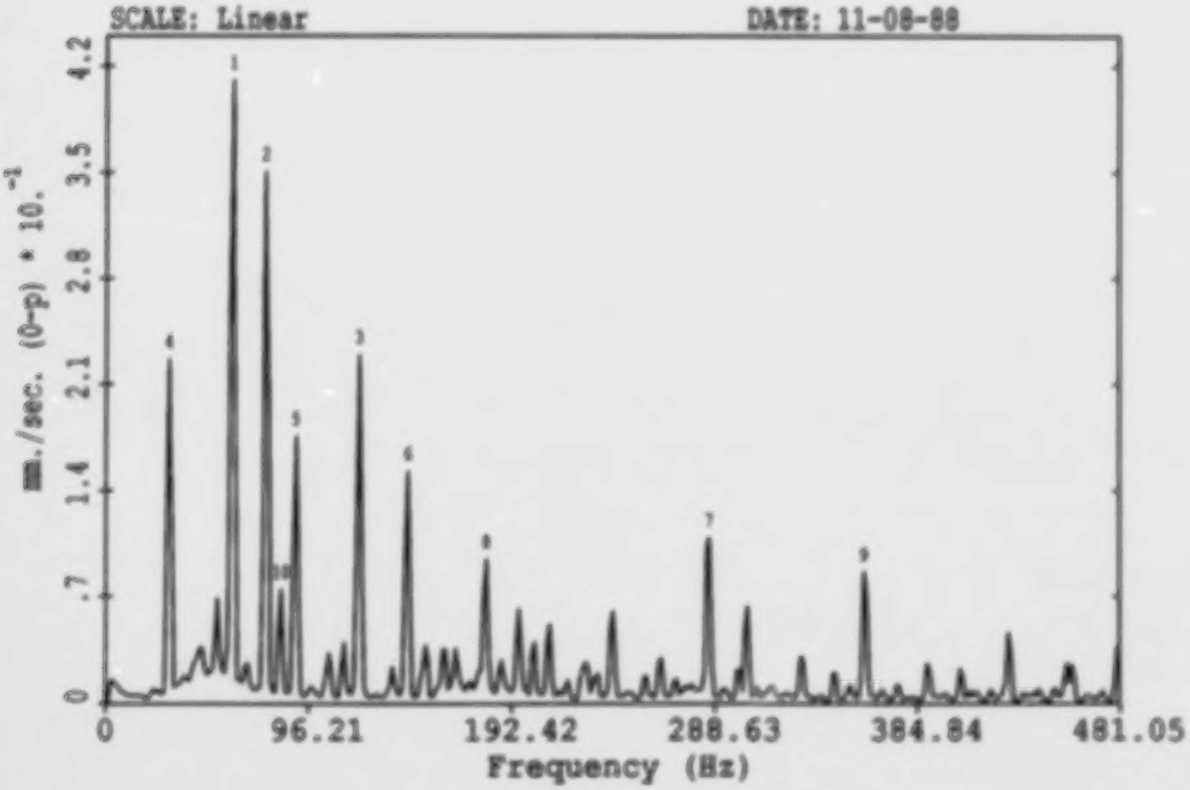


FIGURE C21

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Reduction Gear Box Casing Velocity Axial
PROCESS CONDITION : Load 5.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 75.8 | 0.40 |
| 2 | 30.1 | 0.28 |
| 3 | 60.1 | 0.26 |
| 4 | 120.3 | 0.25 |
| 5 | 143.1 | 0.17 |
| 6 | 286.2 | 0.16 |
| 7 | 90.2 | 0.12 |
| 8 | 359.6 | 0.09 |
| 9 | 304.3 | 0.07 |
| 10 | 180.4 | 0.07 |

SCALE: Linear

DATE: 11-08-88

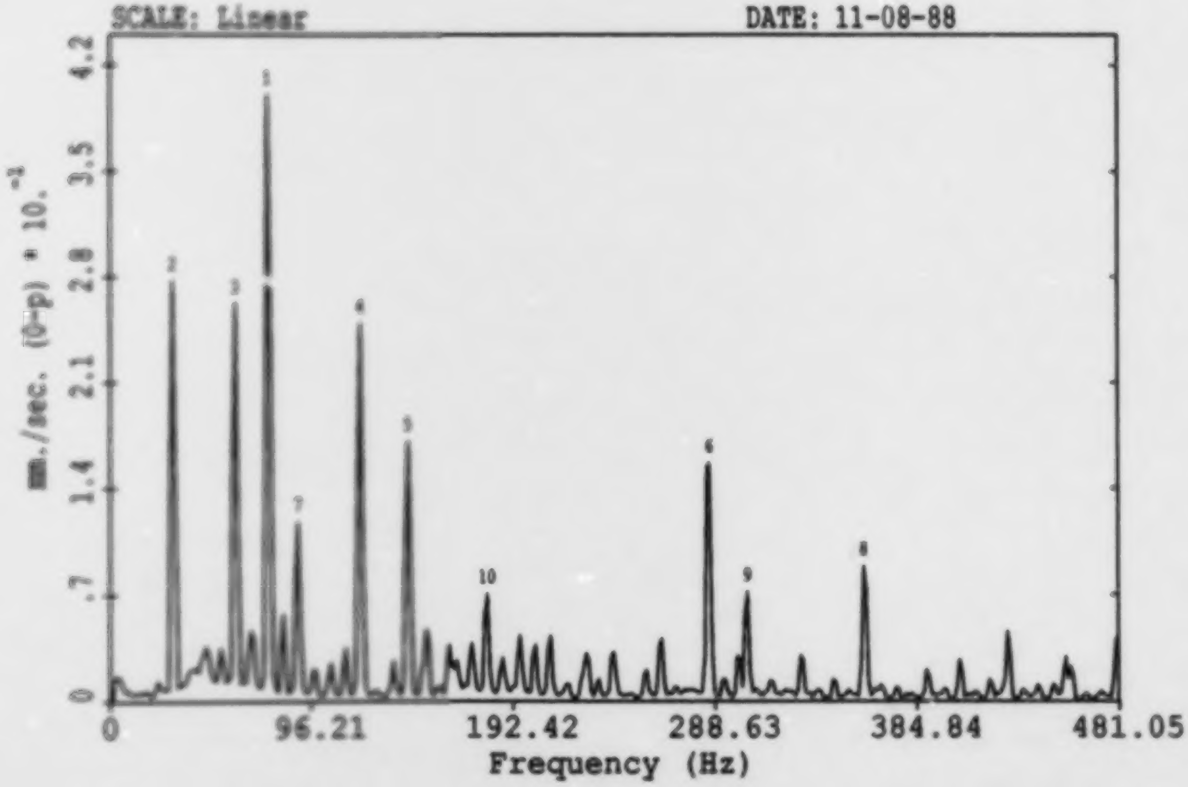


FIGURE C22

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Reduction Gear Box Casing Velocity Axial
PROCESS CONDITION : Load 6.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 75.8 | 0.49 |
| 2 | 30.1 | 0.35 |
| 3 | 120.3 | 0.26 |
| 4 | 60.1 | 0.22 |
| 5 | 143.1 | 0.21 |
| 6 | 286.2 | 0.18 |
| 7 | 90.2 | 0.10 |
| 8 | 180.4 | 0.10 |
| 9 | 359.6 | 0.09 |
| 10 | 304.3 | 0.08 |

SCALE: Linear

DATE: 11-08-88

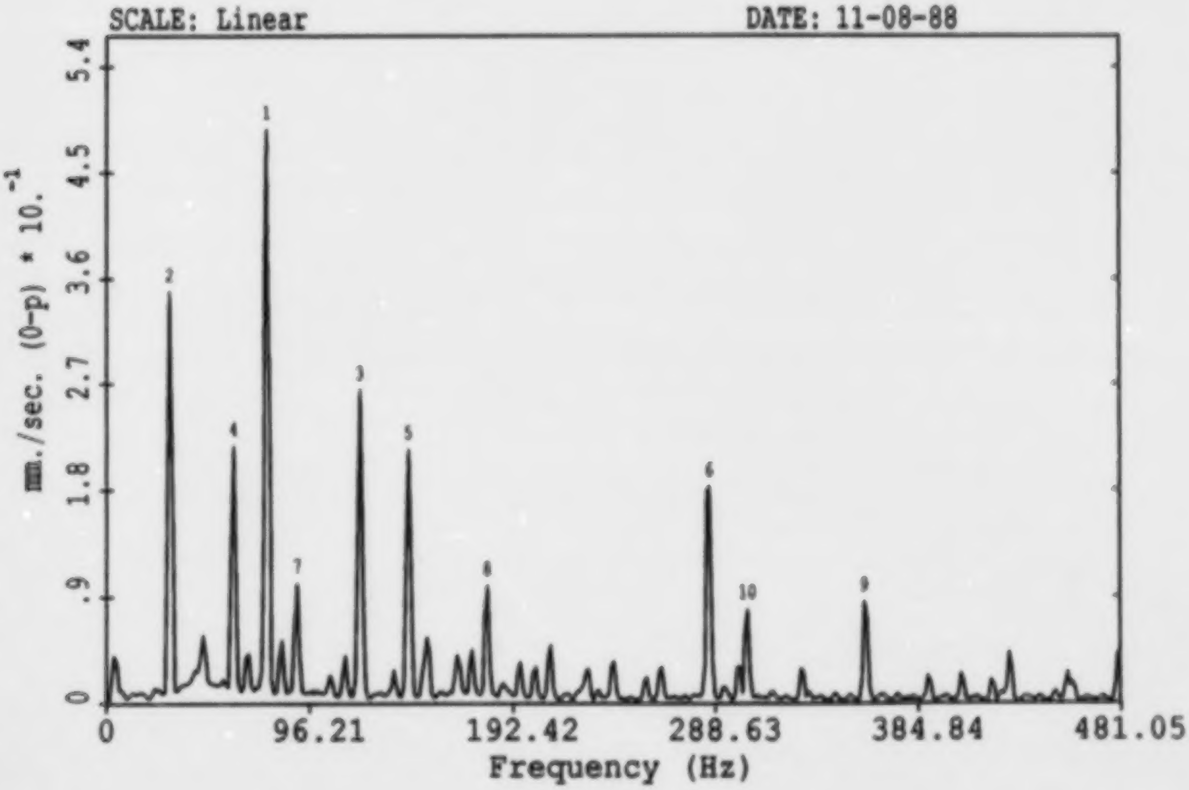


FIGURE C23

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Reduction Gear Box Casing Velocity Axial
PROCESS CONDITION : Load 6.9 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 75.8 | 0.52 |
| 2 | 30.1 | 0.38 |
| 3 | 120.3 | 0.28 |
| 4 | 143.1 | 0.23 |
| 5 | 60.1 | 0.22 |
| 6 | 286.2 | 0.20 |
| 7 | 180.4 | 0.09 |
| 8 | 90.2 | 0.09 |
| 9 | 359.6 | 0.09 |
| 10 | 304.3 | 0.08 |

SCALE: Linear

DATE: 11-08-88

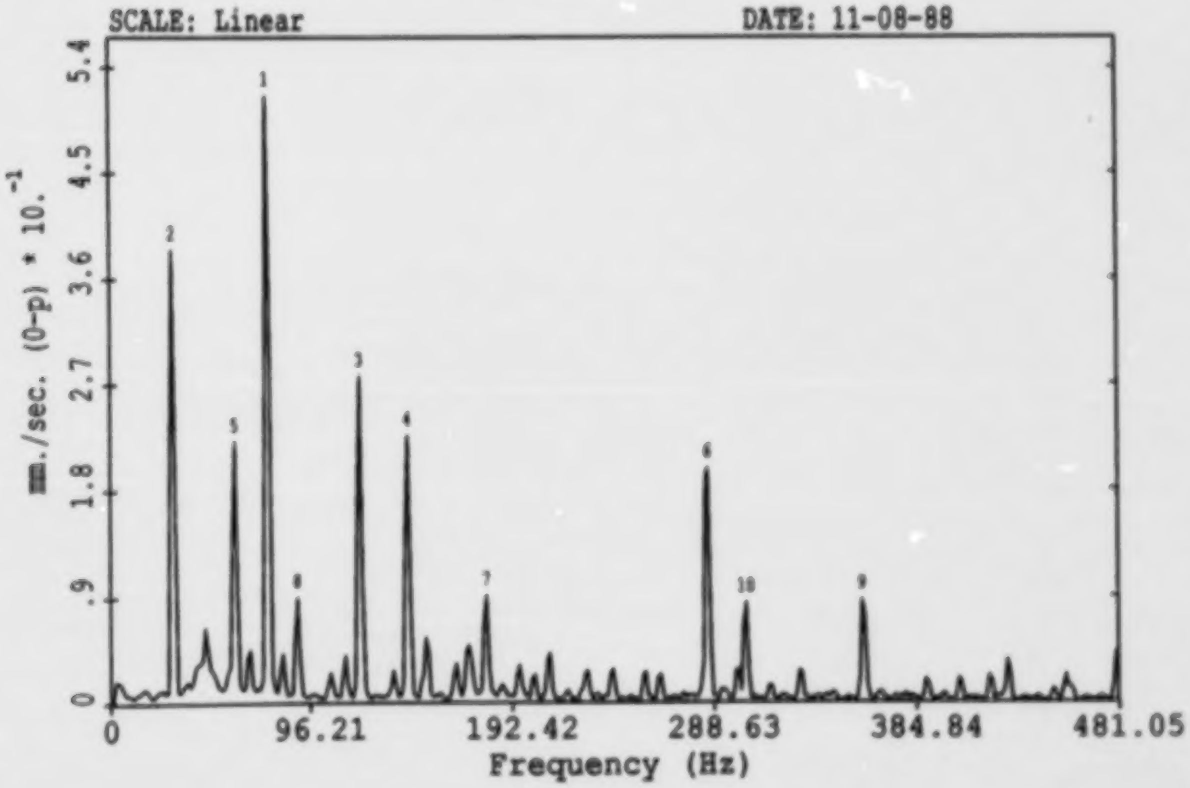


FIGURE C24

# APPENDIX D

# POWER TURBINE VELOCITY AND DISPLACEMENT SPECTRA

# TABLE D1

## DARLINGTON NGS 'A' EMERGENCY POWER GENERATOR #1 - POWER TURBINE

## FIGURE NUMBERS OF VELOCITY AND DISPLACEMENT SPECTRA

| Measurement | | FFT Spectrum Figure No. Load (MW) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 6.9 |
| **Bearing No 5 Casing Velocity** | Vertical Direction | D1 | D2 | D3 | D4 | D5 | D6 | D7 | D8 |
| | Horizontal Direction | D9 | D10 | D11 | D12 | D13 | D14 | D15 | D16 |
| | Axial Direction | D17 | D18 | D19 | D20 | D21 | D22 | D23 | D24 |
| **Bearing No 4 Shaft Displacement** | Vertical Direction | D25 | D26 | D27 | D28 | D29 | D30 | D31 | D32 |
| | Horizontal Direction | D33 | D34 | D35 | D36 | D37 | D38 | D39 | D40 |
| **Bearing No 5 Shaft Displacement** | Vertical Direction | D41 | D42 | D43 | D44 | D45 | D46 | D47 | D48 |
| | Horizontal Direction | D49 | D50 | D51 | D52 | D53 | D54 | D55 | D56 |

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : PT Bearing #5 Casing Velocity Vert.
PROCESS CONDITION : Load 0.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 143.1 | 5.23 |
| 2 | 60.1 | 1.55 |
| 3 | 147.9 | 1.04 |
| 4 | 30.1 | 0.97 |
| 5 | 75.8 | 0.86 |
| 6 | 64.9 | 0.78 |
| 7 | 71.0 | 0.74 |
| 8 | 285.0 | 0.58 |
| 9 | 40. | 0.49 |
| 10 | 120. | 0.45 |

SCALE: Linear

DATE: 08-11-88

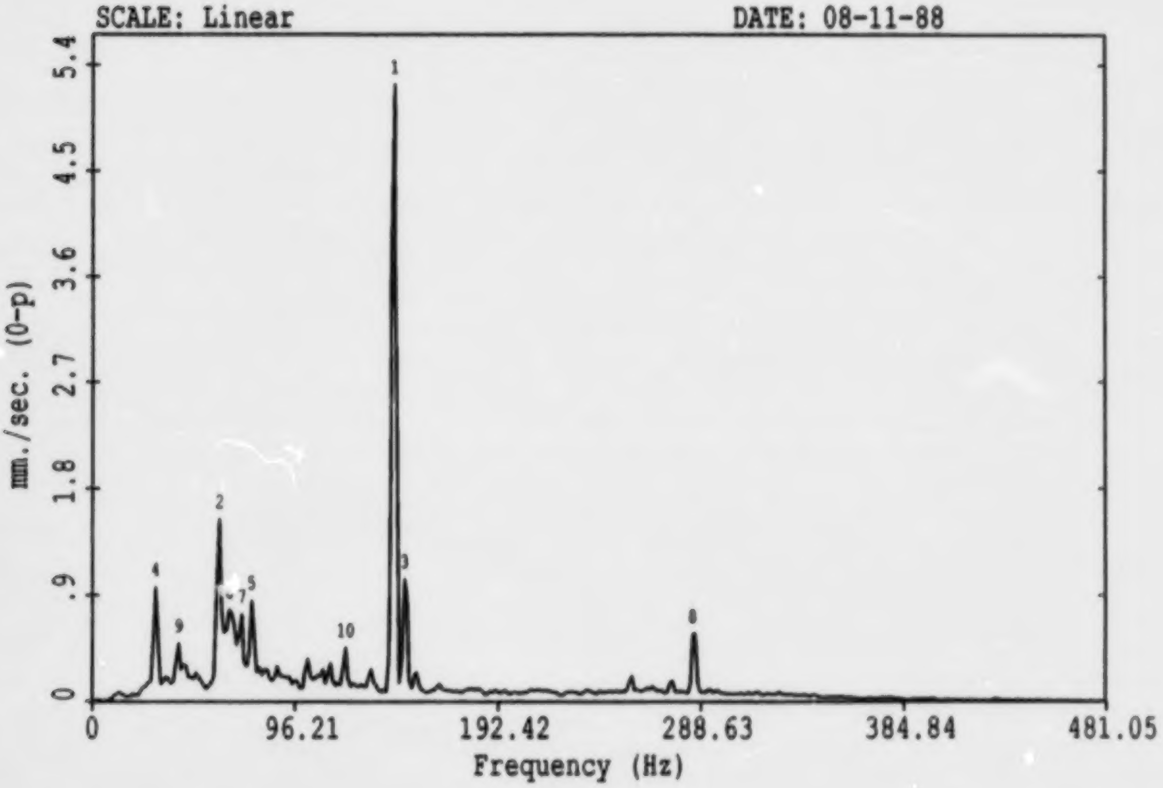


FIGURE D1

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : PT Bearing #5 Casing Velocity Vert.
PROCESS CONDITION : Load 1.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 143.1 | 5.71 |
| 2 | 80.6 | 1.43 |
| 3 | 64.9 | 1.38 |
| 4 | 55.3 | 1.33 |
| 5 | 60.1 | 1.28 |
| 6 | 75.8 | 0.96 |
| 7 | 151.5 | 0.88 |
| 8 | 50.5 | 0.74 |
| 9 | 25.3 | 0.72 |
| 10 | 286.2 | 0.70 |

SCALE: Linear

DATE: 08-11-88

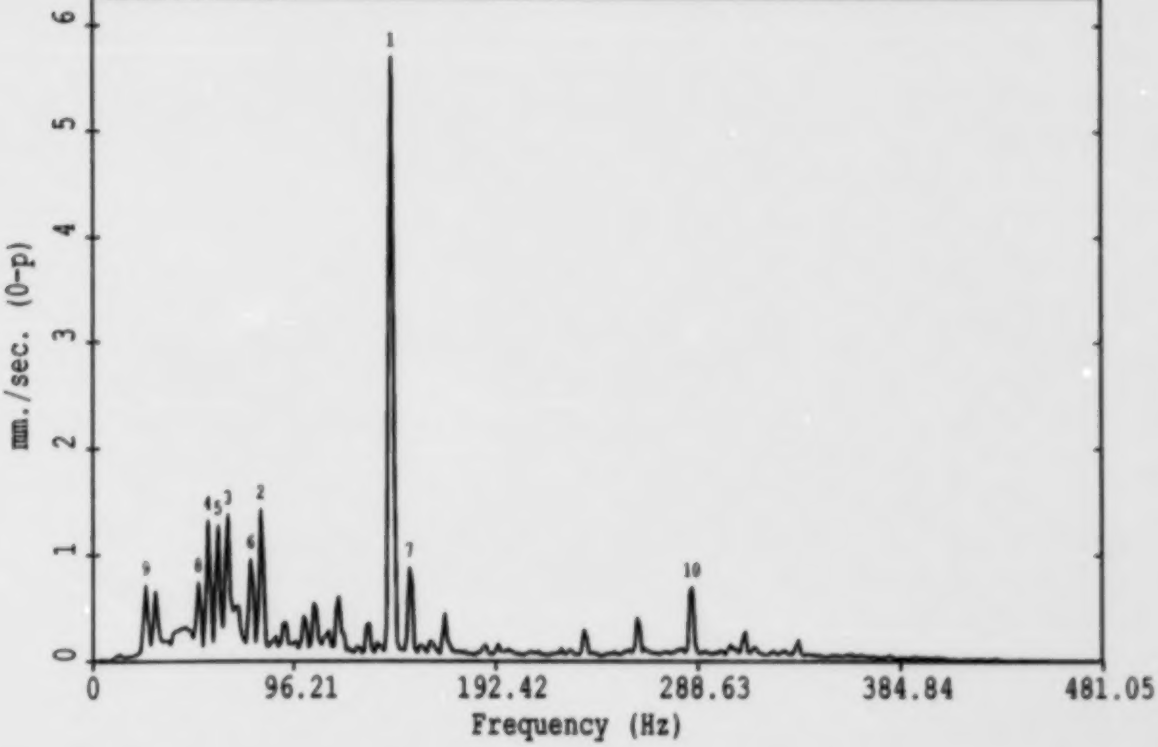


FIGURE D2

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : PT Bearing #5 Casing Velocity Vert.
PROCESS CONDITION : Load 2.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 143.1 | 5.88 |
| 2 | 60.1 | 3.90 |
| 3 | 30.1 | 2.25 |
| 4 | 75.8 | 1.41 |
| 5 | 286.2 | 1.16 |
| 6 | 64.9 | 0.79 |
| 7 | 120.3 | 0.69 |
| 8 | 155.1 | 0.62 |
| 9 | 90.2 | 0.61 |
| 10 | 105.8 | 0.49 |

SCALE: Linear DATE: 08-11-88

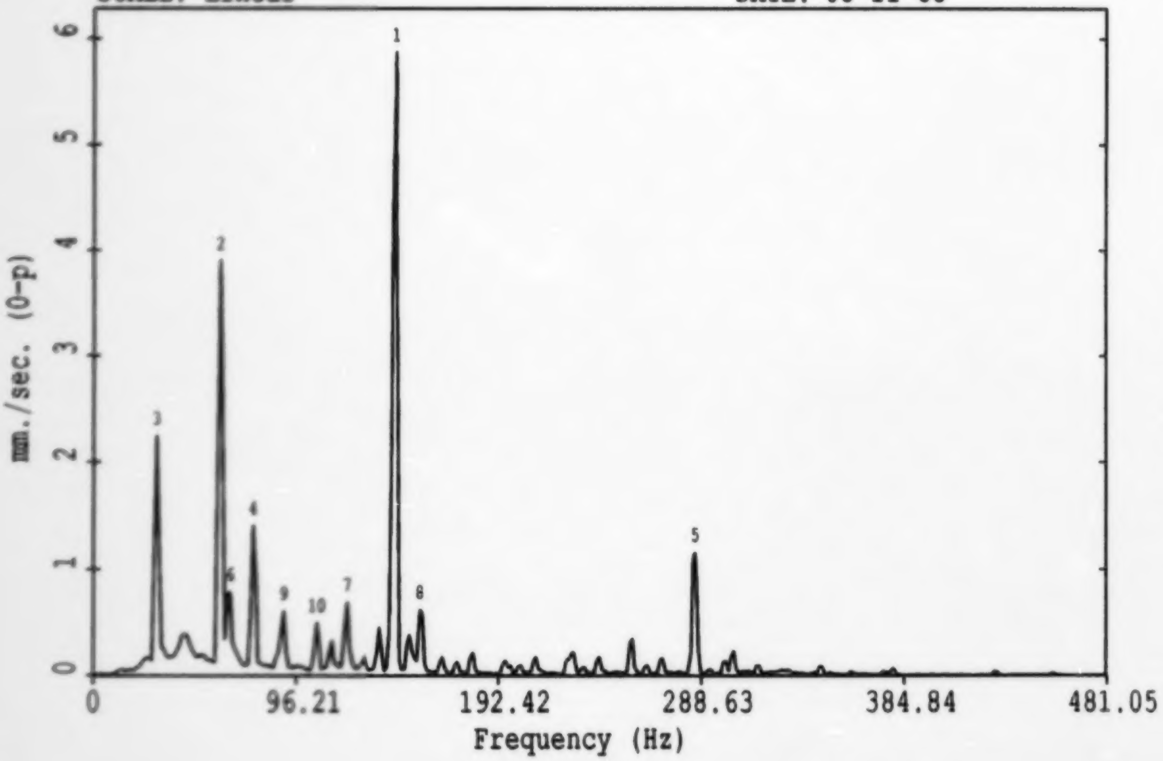


FIGURE D3

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : PT Bearing #5 Casing Velocity Vert.
PROCESS CONDITION : Load 3.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 143.1 | 5.58 |
| 2 | 60.1 | 2.61 |
| 3 | 30.1 | 2.23 |
| 4 | 75.8 | 1.46 |
| 5 | 286.2 | 1.14 |
| 6 | 120.3 | 1.03 |
| 7 | 158.7 | 0.65 |
| 8 | 90.2 | 0.47 |
| 9 | 42.1 | 0.46 |
| 10 | 150.3 | 0.45 |

SCALE: Linear DATE: 08-11-88

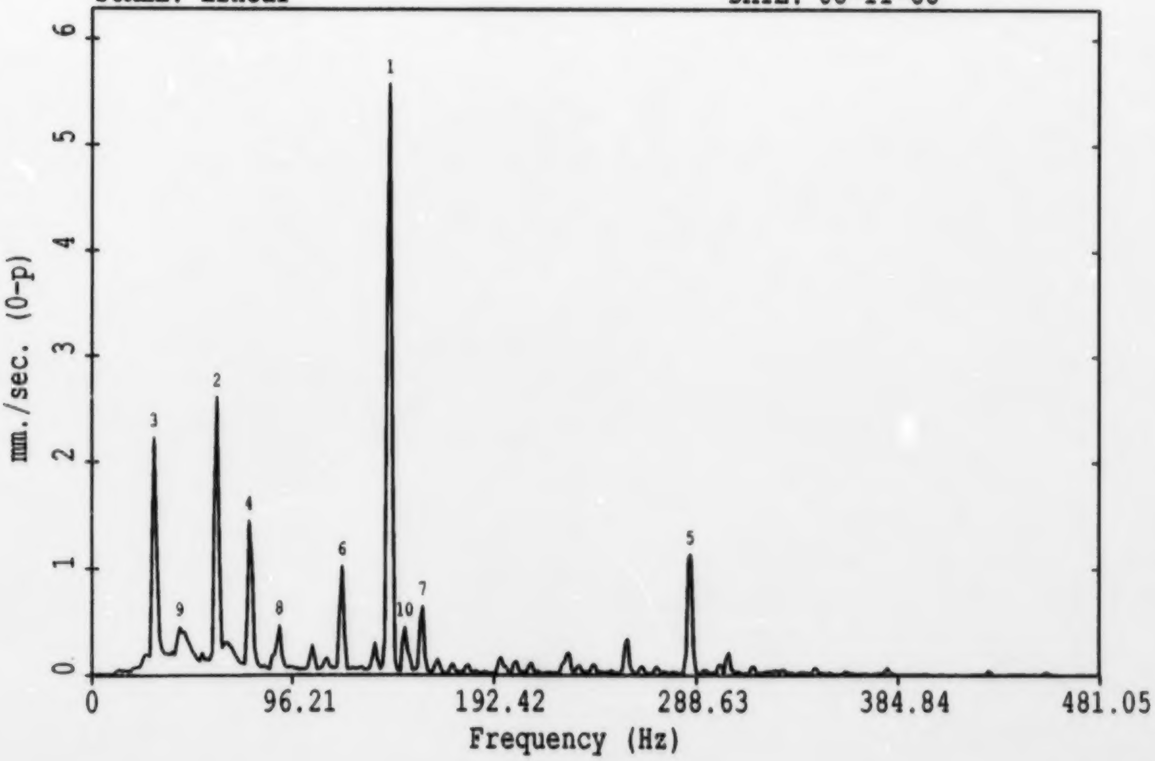


FIGURE D4

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : PT Bearing #5 Casing Velocity Vert.
PROCESS CONDITION : Load 4.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 143.1 | 5.61 |
| 2 | 30.1 | 2.65 |
| 3 | 60.1 | 2.35 |
| 4 | 75.8 | 1.49 |
| 5 | 286.2 | 1.31 |
| 6 | 120.3 | 1.00 |
| 7 | 43.3 | 0.49 |
| 8 | 160.0 | 0.47 |
| 9 | 45.7 | 0.40 |
| 10 | 33.7 | 0.39 |

SCALE: Linear DATE: 08-11-88

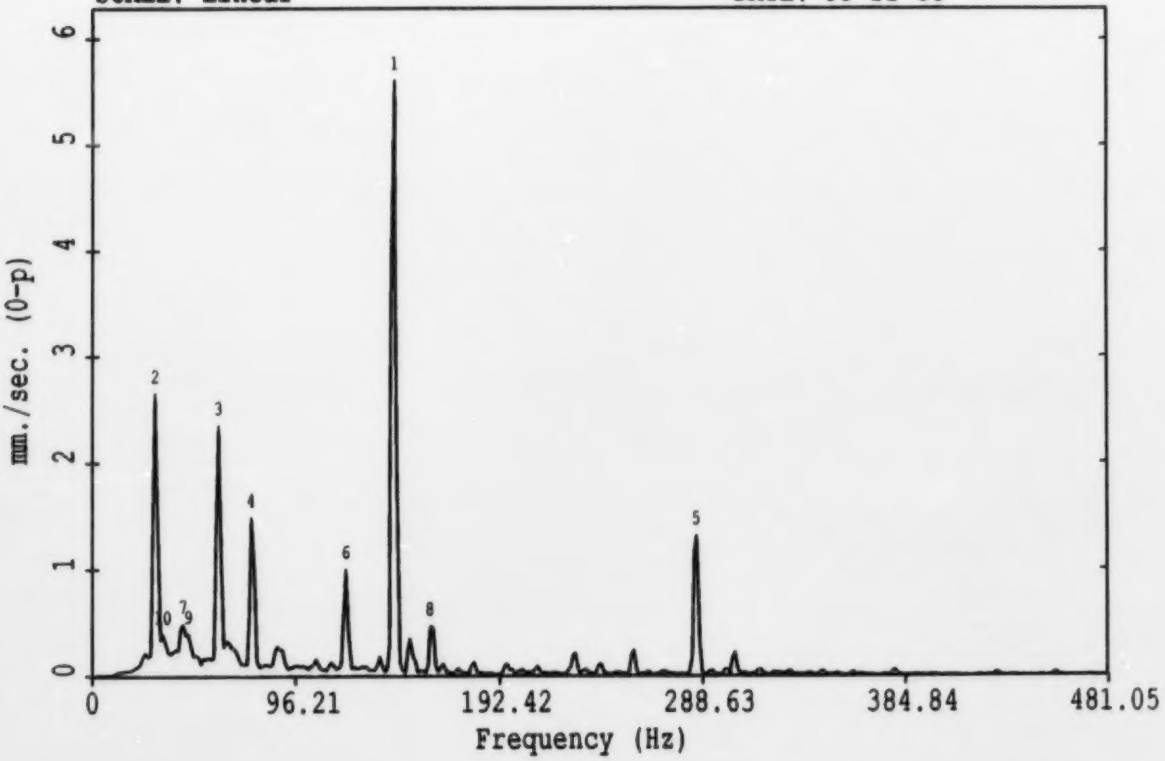


FIGURE D5

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : PT Bearing #5 Casing Velocity Vert.
PROCESS CONDITION : Load 5.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 143.1 | 5.60 |
| 2 | 30.1 | 2.83 |
| 3 | 60.1 | 1.99 |
| 4 | 75.8 | 1.60 |
| 5 | 286.2 | 1.32 |
| 6 | 120.3 | 0.96 |
| 7 | 97.4 | 0.70 |
| 8 | 162.4 | 0.56 |
| 9 | 44.5 | 0.45 |
| 10 | 40.9 | 0.44 |

SCALE: Linear DATE: 08-11-88

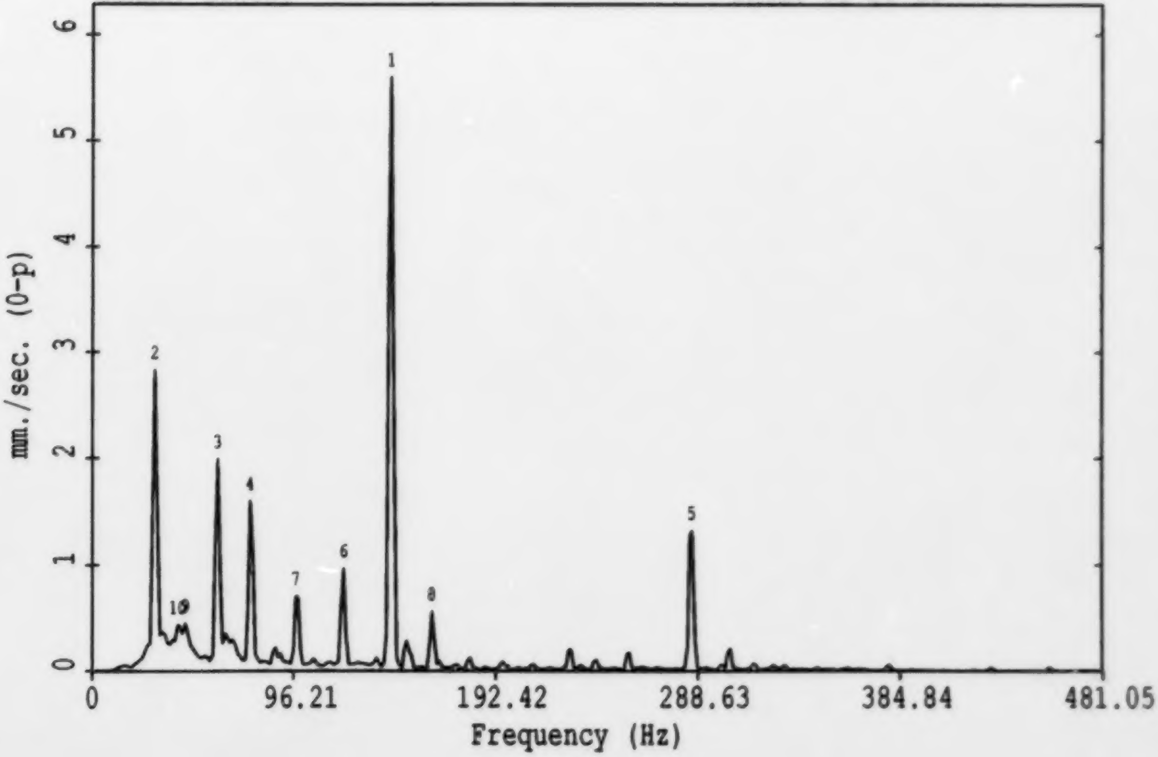


**FIGURE D6**

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : PT Bearing #5 Casing Velocity Vert.
PROCESS CONDITION : Load 6.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 143.1 | 5.73 |
| 2 | 30.1 | 3.26 |
| 3 | 60.1 | 1.80 |
| 4 | 75.8 | 1.80 |
| 5 | 286.2 | 1.37 |
| 6 | 120.3 | 1.13 |
| 7 | 167.2 | 0.79 |
| 8 | 42.1 | 0.60 |
| 9 | 38.5 | 0.36 |
| 10 | 46.9 | 0.34 |

SCALE: Linear DATE: 08-11-88

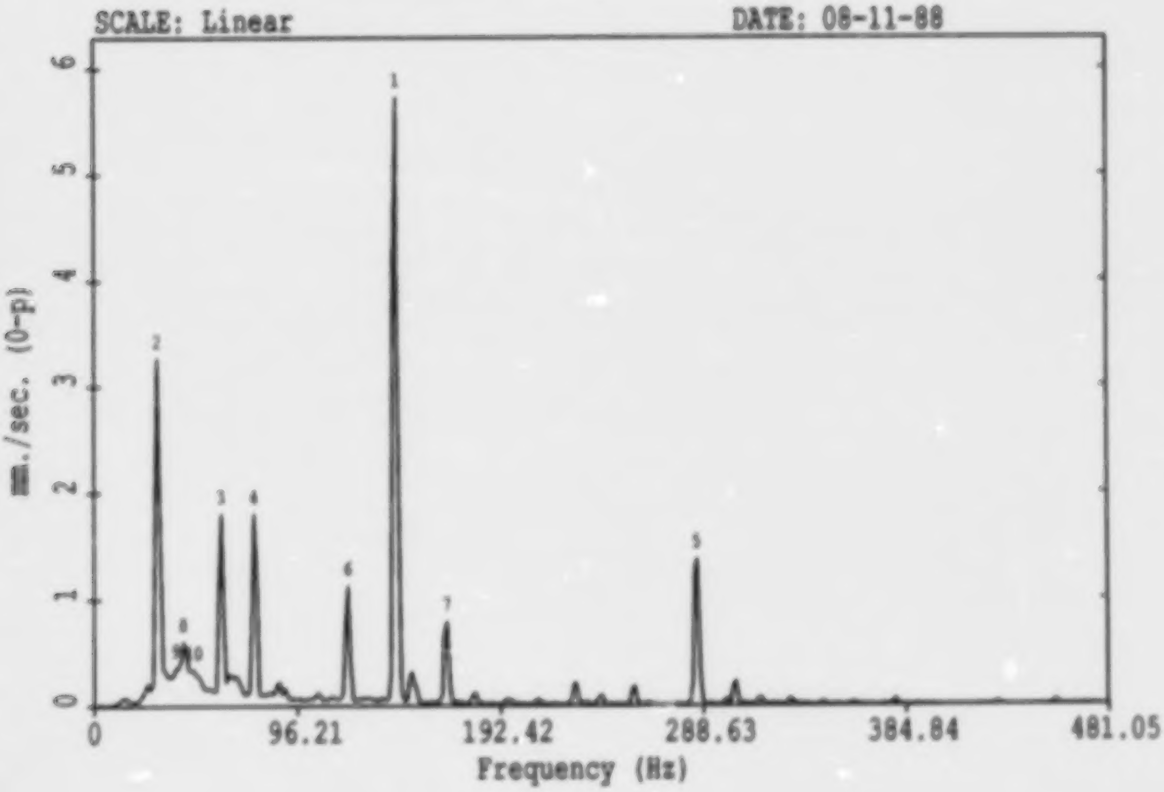


FIGURE D7

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : PT Bearing #5 Casing Velocity Vert.
PROCESS CONDITION : Load 6.9 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 143.1 | 5.88 |
| 2 | 30.1 | 3.00 |
| 3 | 75.8 | 1.89 |
| 4 | 60.1 | 1.85 |
| 5 | 286.2 | 1.31 |
| 6 | 120.3 | 1.08 |
| 7 | 172.0 | 0.86 |
| 8 | 40.9 | 0.57 |
| 9 | 43.3 | 0.57 |
| 10 | 49.3 | 0.52 |

SCALE: Linear

DATE: 08-11-88

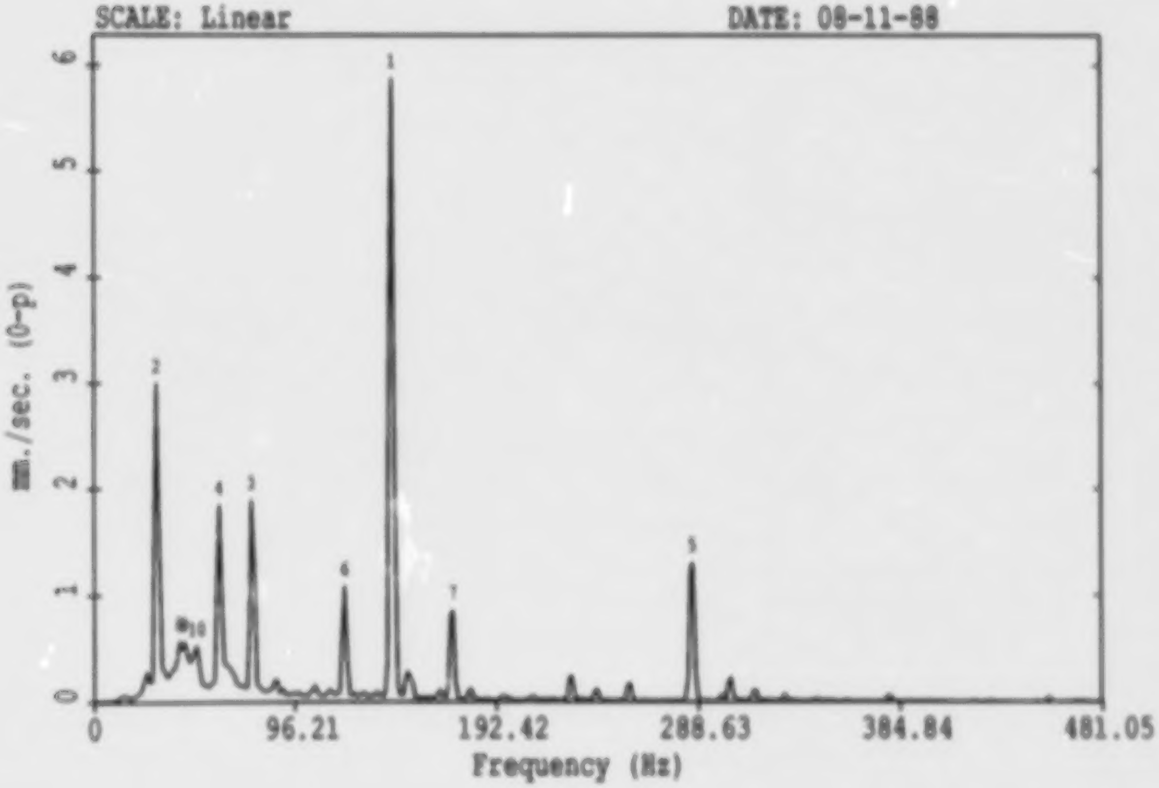


FIGURE D8

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : PT Bearing #5 Casing Velocity Horiz.
PROCESS CONDITION : Load 0.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 143.1 | 6.01 |
| 2 | 30.1 | 2.74 |
| 3 | 60.1 | 1.39 |
| 4 | 147.9 | 1.13 |
| 5 | 24.1 | 0.87 |
| 6 | 26.5 | 0.63 |
| 7 | 286.2 | 0.50 |
| 8 | 64.9 | 0.47 |
| 9 | 153.9 | 0.41 |
| 10 | 132.3 | 0.38 |

SCALE: Linear DATE: 08-11-88

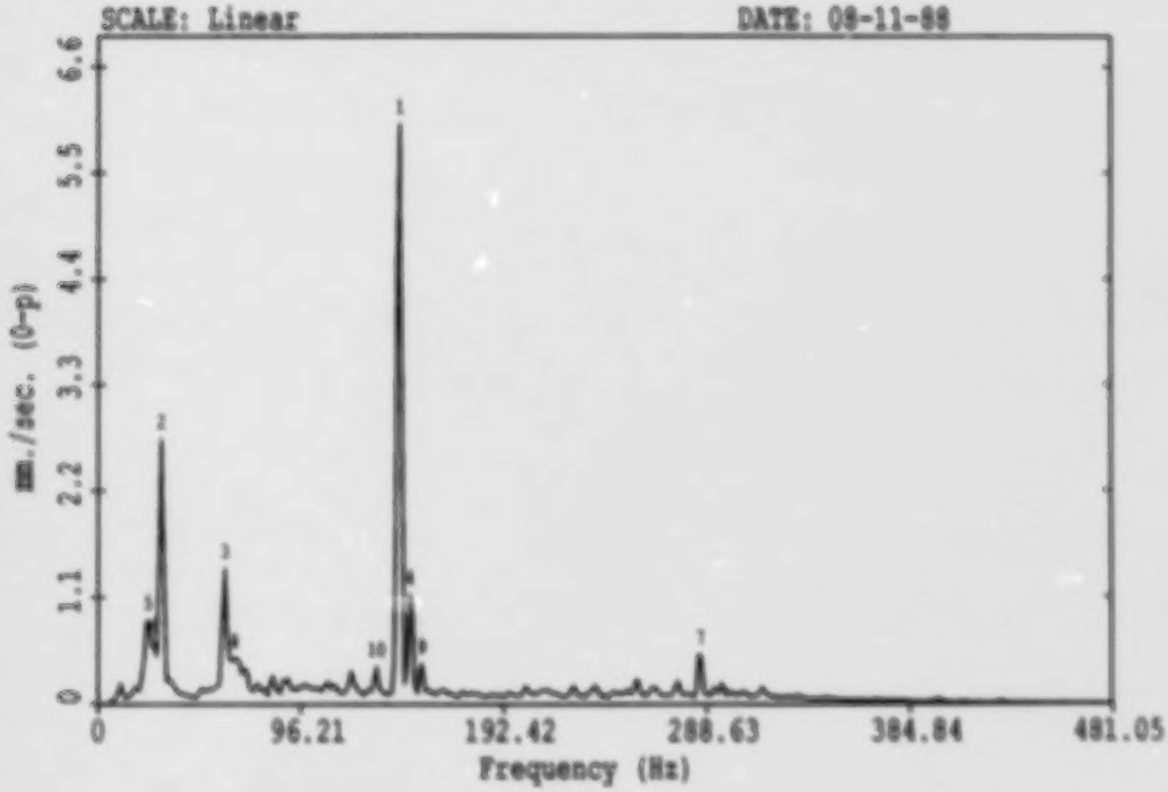


FIGURE D9

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : PT Bearing #5 Casing Velocity Horiz.
PROCESS CONDITION : Load 1.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 143.1 | 6.20 |
| 2 | 30.1 | 2.57 |
| 3 | 60.1 | 2.13 |
| 4 | 25.3 | 1.97 |
| 5 | 64.9 | 1.28 |
| 6 | 75.8 | 1.22 |
| 7 | 55.3 | 1.18 |
| 8 | 80.6 | 0.91 |
| 9 | 102.2 | 0.90 |
| 10 | 151.5 | 0.88 |

SCALE: Linear DATE: 08-11-88

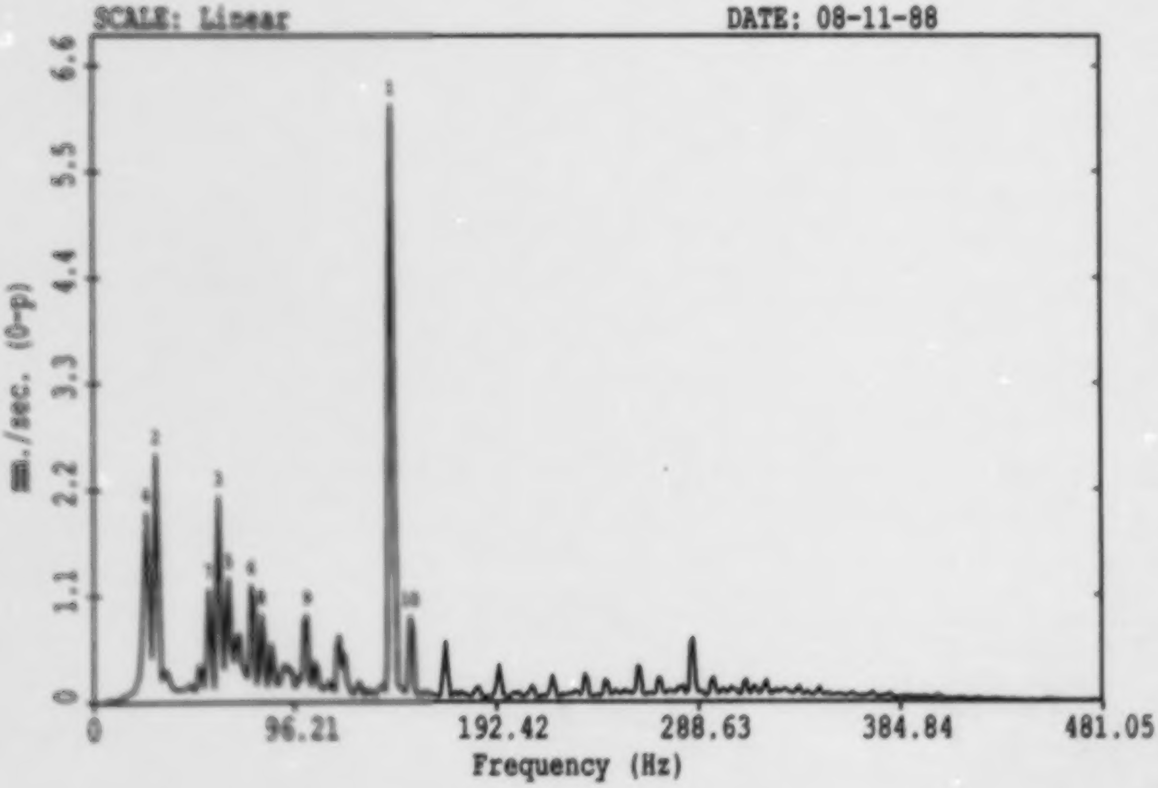


FIGURE D10

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : PT Bearing #5 Casing Velocity Horiz.
PROCESS CONDITION : Load 2.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 143.1 | 6.81 |
| 2 | 60.1 | 6.25 |
| 3 | 30.1 | 4.00 |
| 4 | 120.3 | 2.50 |
| 5 | 286.2 | 1.33 |
| 6 | 90.2 | 1.27 |
| 7 | 75.8 | 1.02 |
| 8 | 24.1 | 1.02 |
| 9 | 105.8 | 0.88 |
| 10 | 113.0 | 0.82 |

SCALE: Linear

DATE: 08-11-88

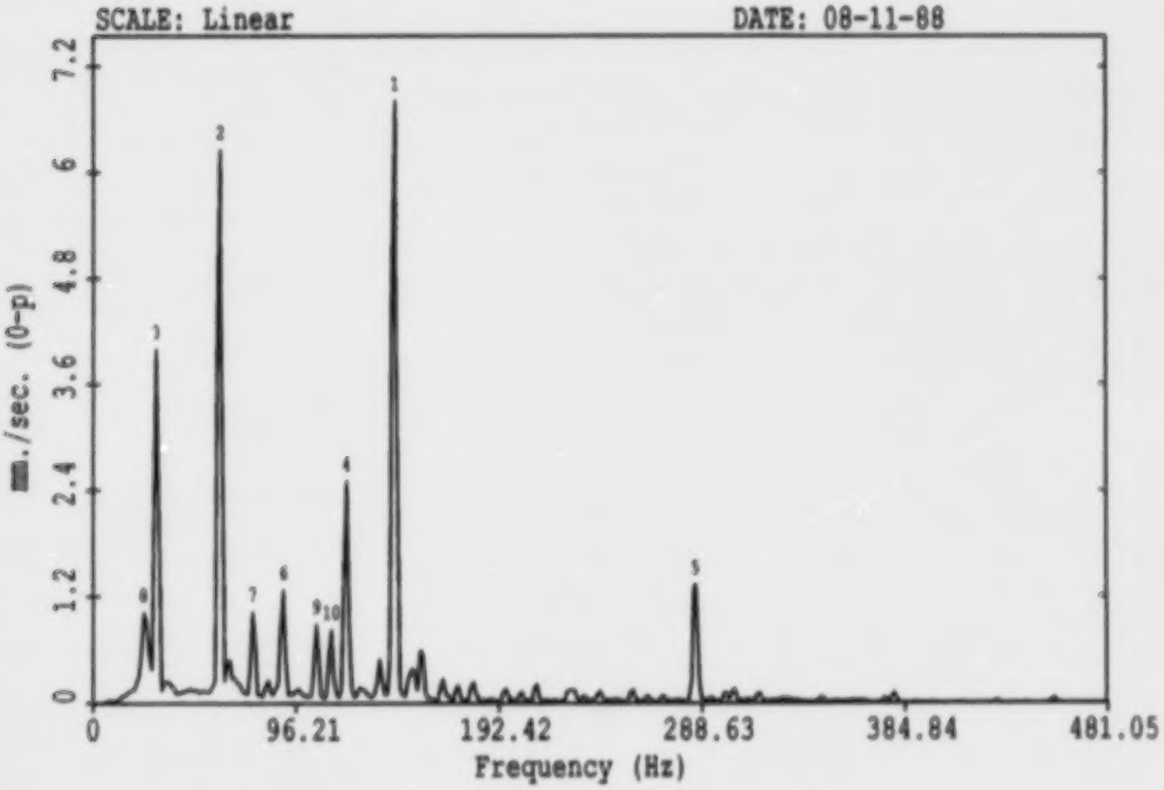


FIGURE D11

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : PT Bearing #5 Casing Velocity Horiz.
PROCESS CONDITION : Load 3.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 143.1 | 5.95 |
| 2 | 60.1 | 4.96 |
| 3 | 30.1 | 3.48 |
| 4 | 120.3 | 1.54 |
| 5 | 25.3 | 1.25 |
| 6 | 286.2 | 1.17 |
| 7 | 75.8 | 1.14 |
| 8 | 90.2 | 1.03 |
| 9 | 158.7 | 0.96 |
| 10 | 151.5 | 0.48 |

SCALE: Linear

DATE: 08-11-88

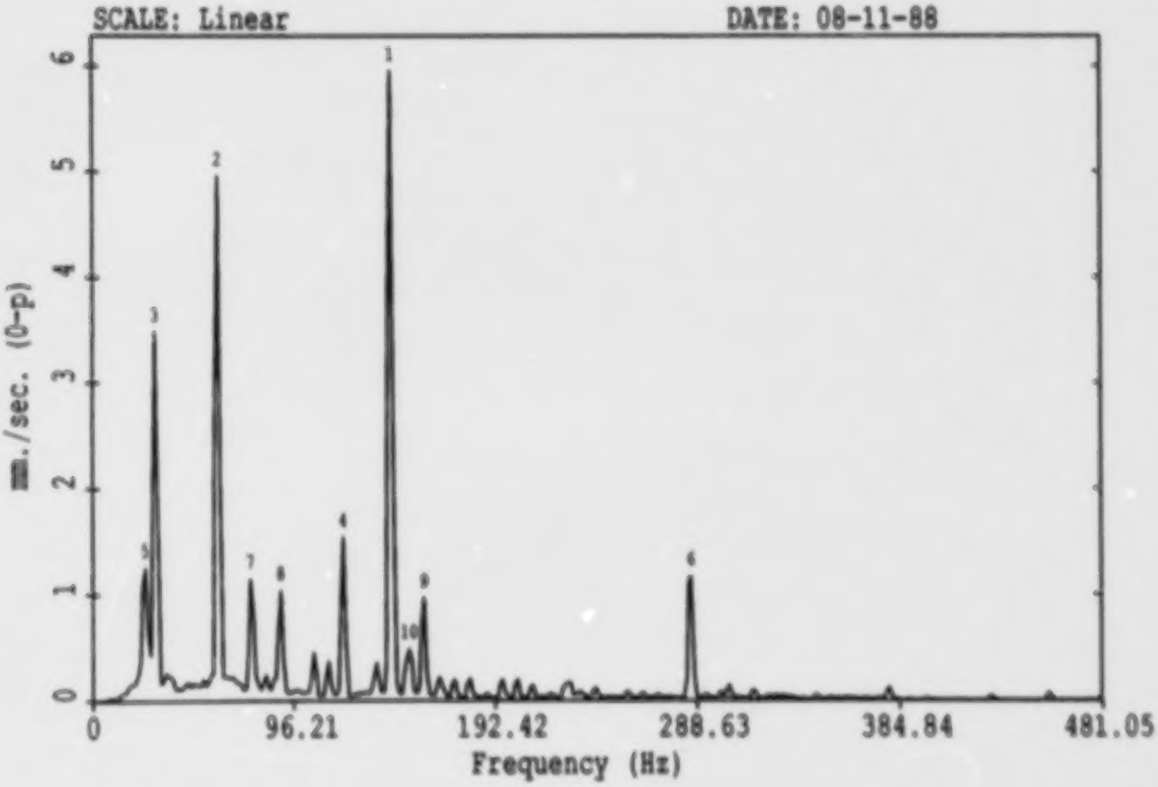


FIGURE D12

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : PT Bearing #5 Casing Velocity Horiz.
PROCESS CONDITION : Load 4.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 143.1 | 5.46 |
| 2 | 60.1 | 3.81 |
| 3 | 30.1 | 3.21 |
| 4 | 25.3 | 1.77 |
| 5 | 120.3 | 1.40 |
| 6 | 75.8 | 1.22 |
| 7 | 286.2 | 0.98 |
| 8 | 161.2 | 0.95 |
| 9 | 90.2 | 0.66 |
| 10 | 151.5 | 0.38 |

SCALE: Linear

DATE: 08-11-88

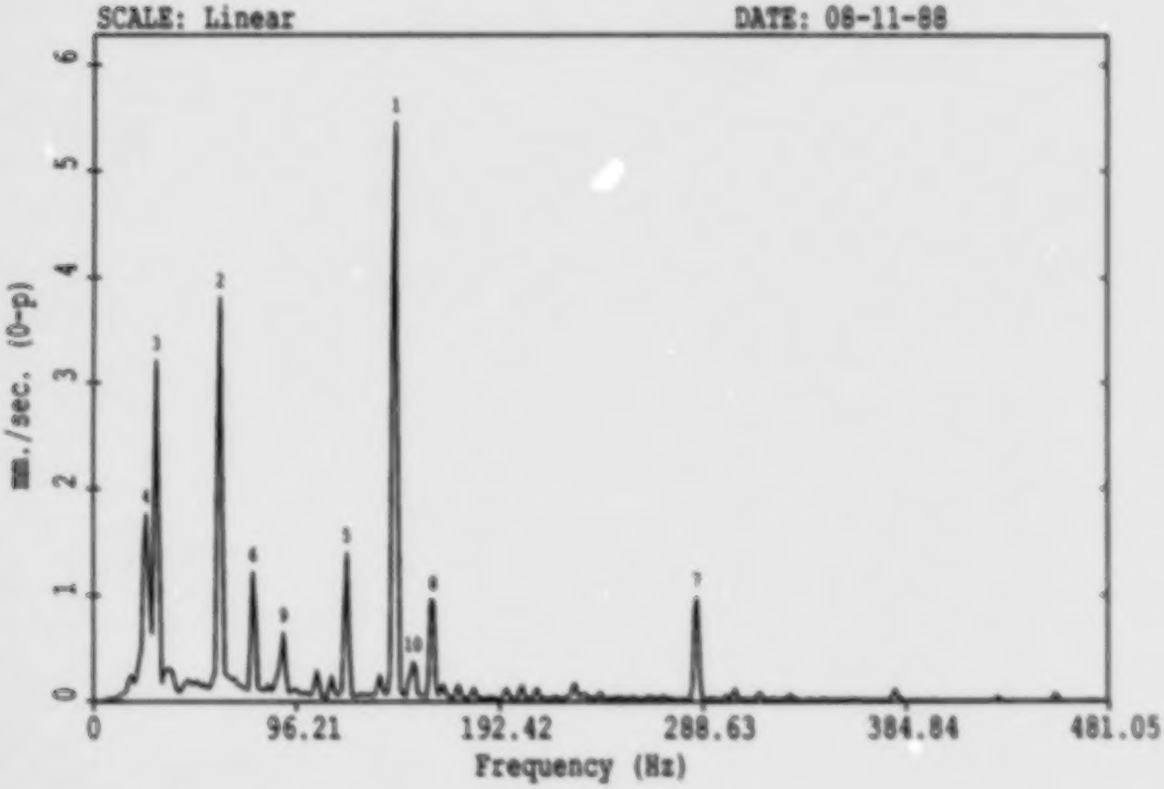


FIGURE D13

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : PT Bearing #5 Casing Velocity Horiz.
PROCESS CONDITION : Load 5.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 143.1 | 5.11 |
| 2 | 60.1 | 3.38 |
| 3 | 30.1 | 3.10 |
| 4 | 120.3 | 1.37 |
| 5 | 25.3 | 1.35 |
| 6 | 75.8 | 1.35 |
| 7 | 162.4 | 1.12 |
| 8 | 286.2 | 0.66 |
| 9 | 97.4 | 0.62 |
| 10 | 90.2 | 0.52 |

SCALE: Linear DATE: 08-11-88

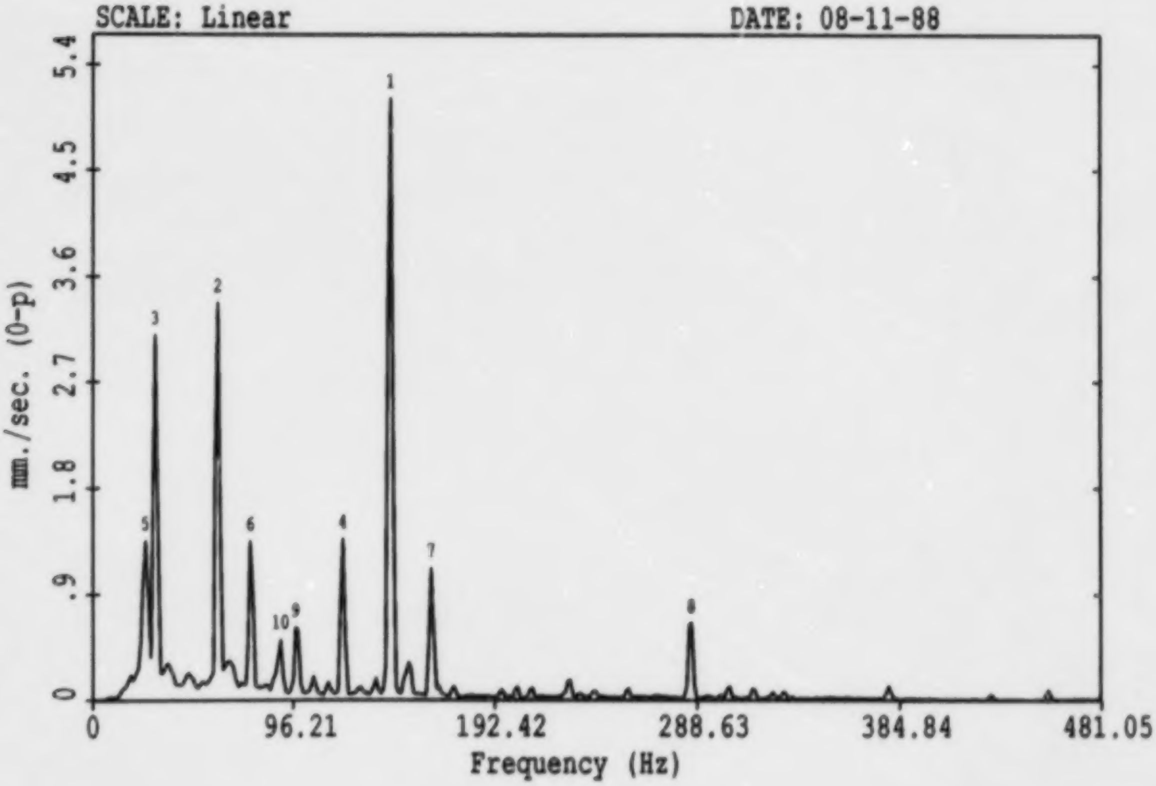


FIGURE D14

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : PT Bearing #5 Casing Velocity Horiz.
PROCESS CONDITION : Load 6.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 143.1 | 5.31 |
| 2 | 60.1 | 3.39 |
| 3 | 30.1 | 3.20 |
| 4 | 75.8 | 1.59 |
| 5 | 25.3 | 1.53 |
| 6 | 120.3 | 1.37 |
| 7 | 167.2 | 0.94 |
| 8 | 286.2 | 0.57 |
| 9 | 90.2 | 0.48 |
| 10 | 151.5 | 0.29 |

SCALE: Linear DATE: 08-11-88

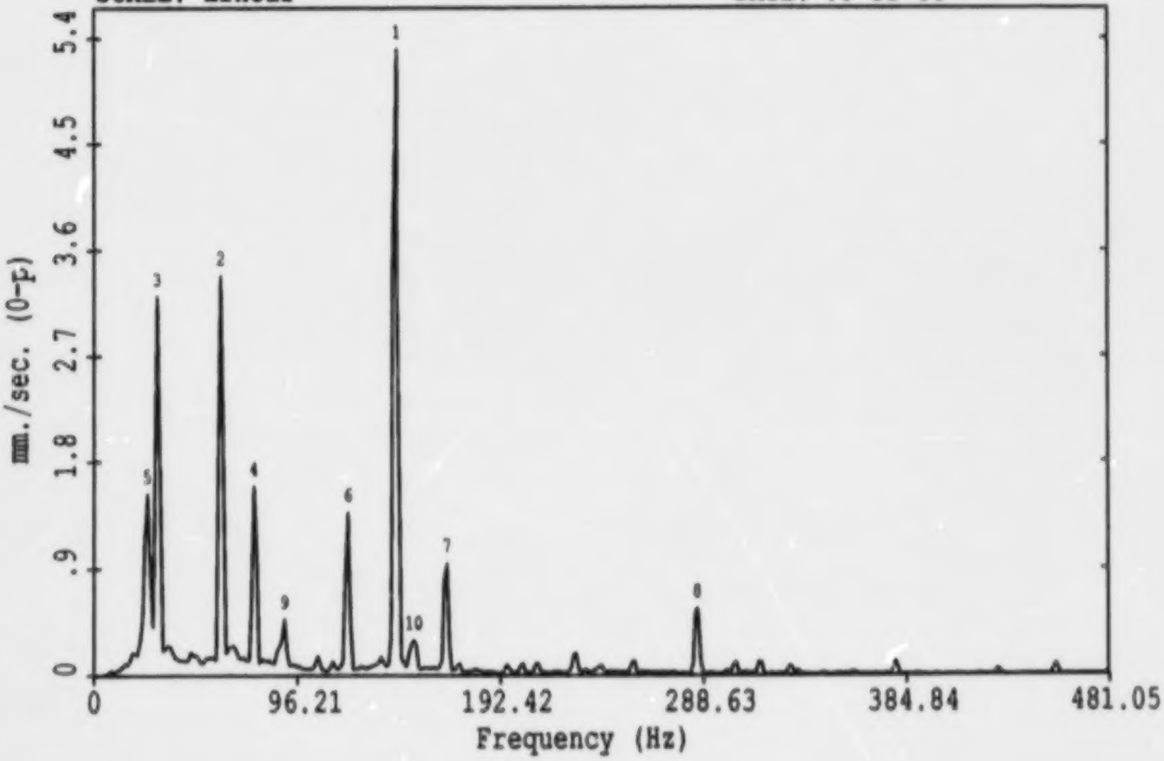


FIGURE D15

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : PT Bearing #5 Casing Velocity Horiz.
PROCESS CONDITION : Load 6.9 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 143.1 | 5.67 |
| 2 | 60.1 | 3.37 |
| 3 | 30.1 | 2.76 |
| 4 | 75.8 | 1.65 |
| 5 | 25.3 | 1.61 |
| 6 | 120.3 | 1.43 |
| 7 | 286.2 | 0.69 |
| 8 | 172.0 | 0.69 |
| 9 | 90.2 | 0.40 |
| 10 | 36.1 | 0.32 |

SCALE: Linear

DATE: 08-11-88

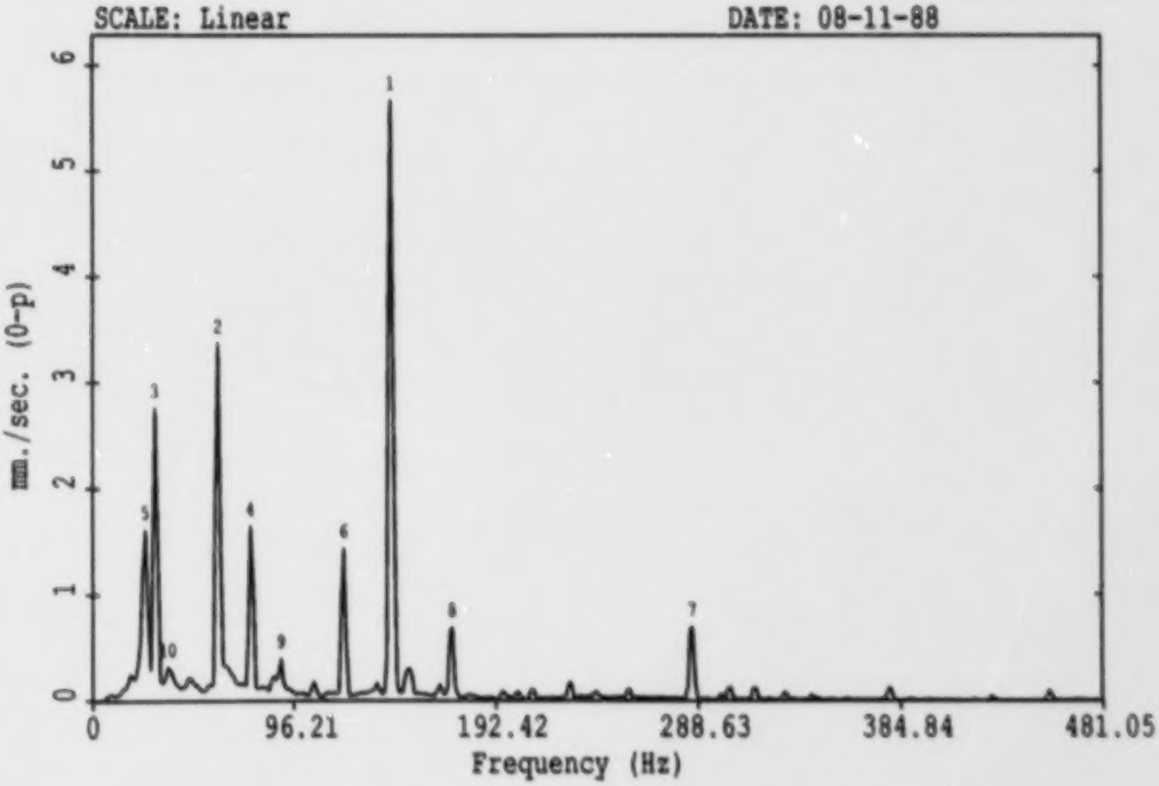


FIGURE D16

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : PT Bearing #5 Casing Velocity Axial
PROCESS CONDITION : Load 0.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 83.0 | 1.91 |
| 2 | 143.1 | 1.37 |
| 3 | 147.9 | 1.04 |
| 4 | 55.3 | 0.82 |
| 5 | 110.6 | 0.78 |
| 6 | 60.1 | 0.42 |
| 7 | 138.3 | 0.36 |
| 8 | 286.2 | 0.28 |
| 9 | 10.8 | 0.27 |
| 10 | 27.7 | 0.24 |

SCALE: Linear

DATE: 08-11-88

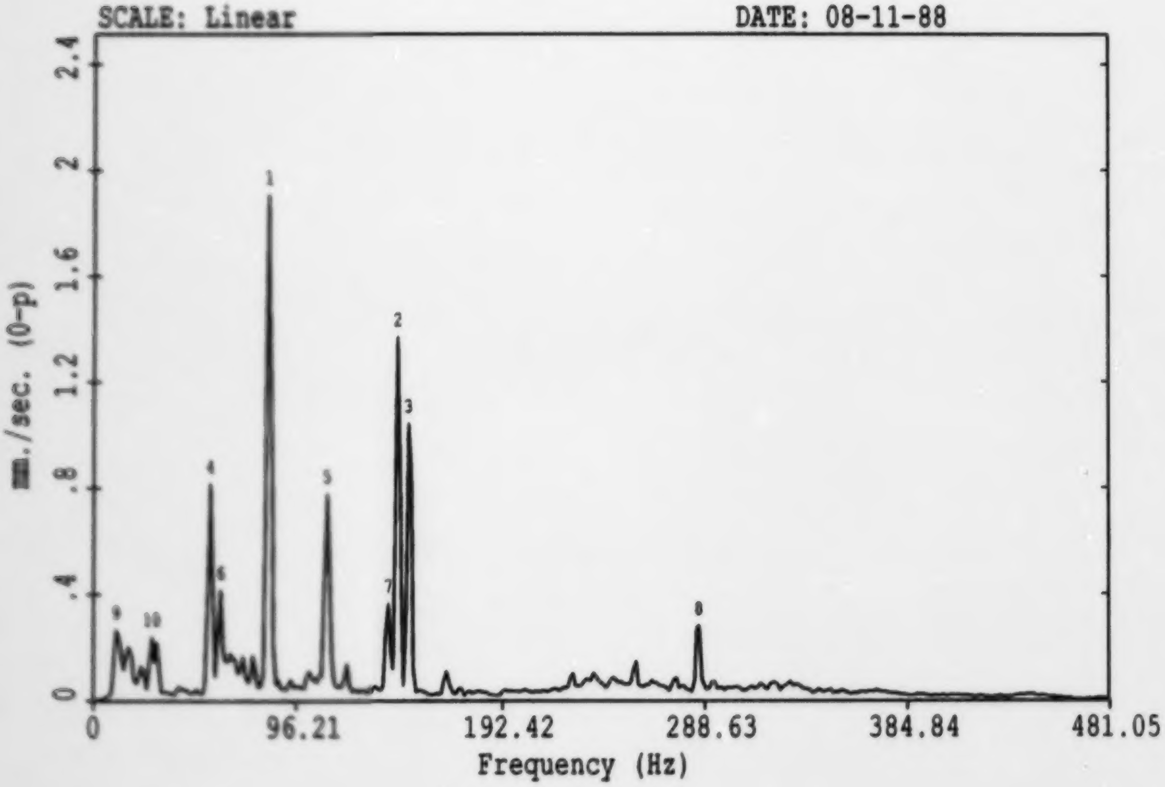
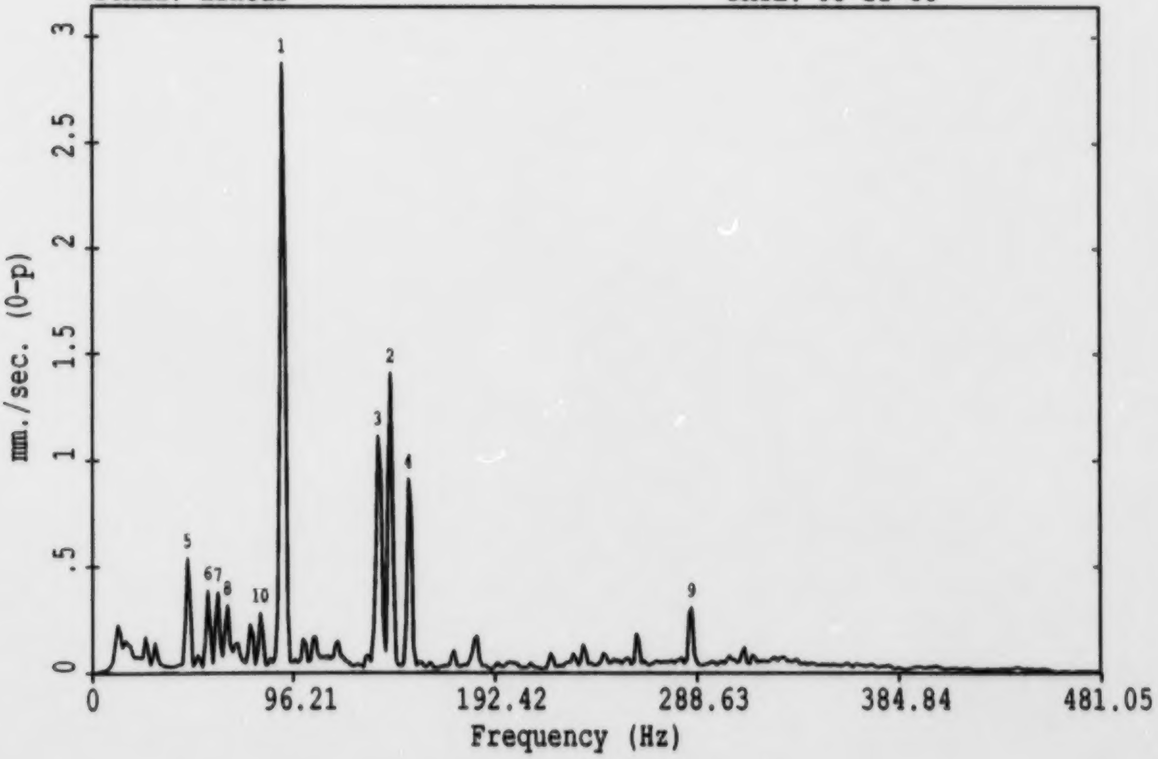


FIGURE D17

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : PT Bearing #5 Casing Velocity Axial
PROCESS CONDITION : Load 1.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 91.4 | 2.88 |
| 2 | 143.1 | 1.41 |
| 3 | 137.1 | 1.12 |
| 4 | 151.5 | 0.92 |
| 5 | 45.7 | 0.54 |
| 6 | 55.3 | 0.39 |
| 7 | 60.1 | 0.38 |
| 8 | 64.9 | 0.32 |
| 9 | 286.2 | 0.31 |
| 10 | 80.6 | 0.28 |



SCALE: Linear

DATE: 08-11-88

FIGURE D18

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : PT Bearing #5 Casing Velocity Axial
PROCESS CONDITION : Load 2.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 128.7 | 2.65 |
| 2 | 143.1 | 1.69 |
| 3 | 64.9 | 1.14 |
| 4 | 60.1 | 1.13 |
| 5 | 155.1 | 0.71 |
| 6 | 30.1 | 0.58 |
| 7 | 193.6 | 0.54 |
| 8 | 286.2 | 0.51 |
| 9 | 75.8 | 0.48 |
| 10 | 105.8 | 0.22 |

SCALE: Linear DATE: 08-11-88

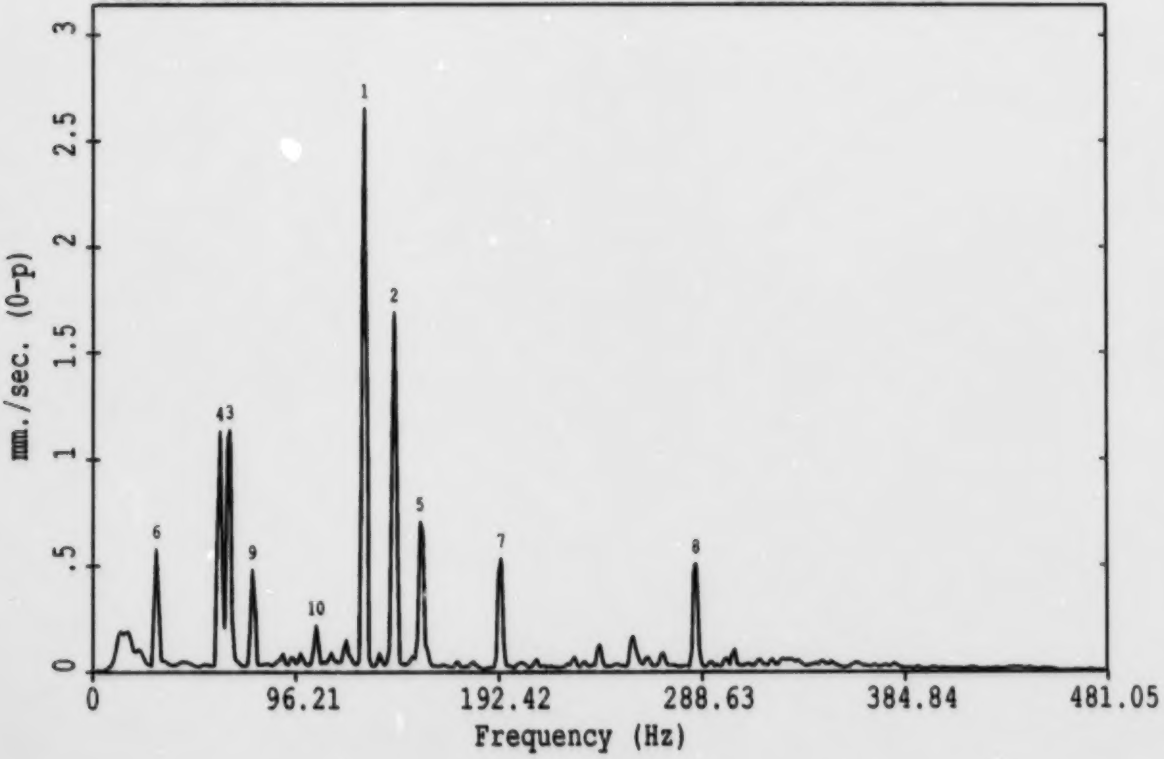


FIGURE D19

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : PT Bearing #5 Casing Velocity Axial
PROCESS CONDITION : Load 3.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 77.0 | 1.95 |
| 2 | 143.1 | 1.62 |
| 3 | 155.1 | 1.28 |
| 4 | 60.1 | 0.78 |
| 5 | 30.1 | 0.58 |
| 6 | 158.7 | 0.57 |
| 7 | 286.2 | 0.52 |
| 8 | 233.3 | 0.20 |
| 9 | 15.6 | 0.20 |
| 10 | 12.0 | 0.18 |

SCALE: Linear

DATE: 08-11-88

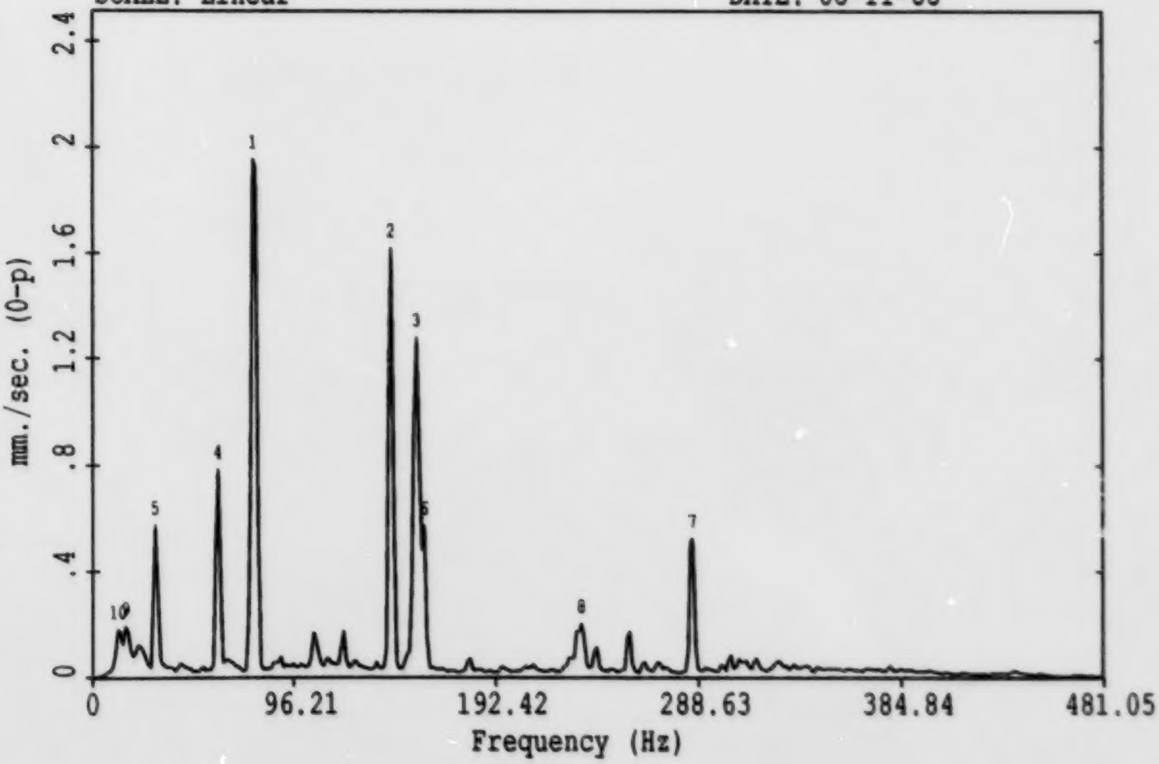


FIGURE D20

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : PT Bearing #5 Casing Velocity Axial
PROCESS CONDITION : Load 4.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 89.0 | 4.19 |
| 2 | 143.1 | 1.48 |
| 3 | 176.8 | 1.00 |
| 4 | 60.1 | 0.66 |
| 5 | 30.1 | 0.64 |
| 6 | 286.2 | 0.58 |
| 7 | 75.8 | 0.57 |
| 8 | 16.8 | 0.30 |
| 9 | 160.0 | 0.25 |
| 10 | 13.2 | 0.20 |

SCALE: Linear DATE: 08-11-88

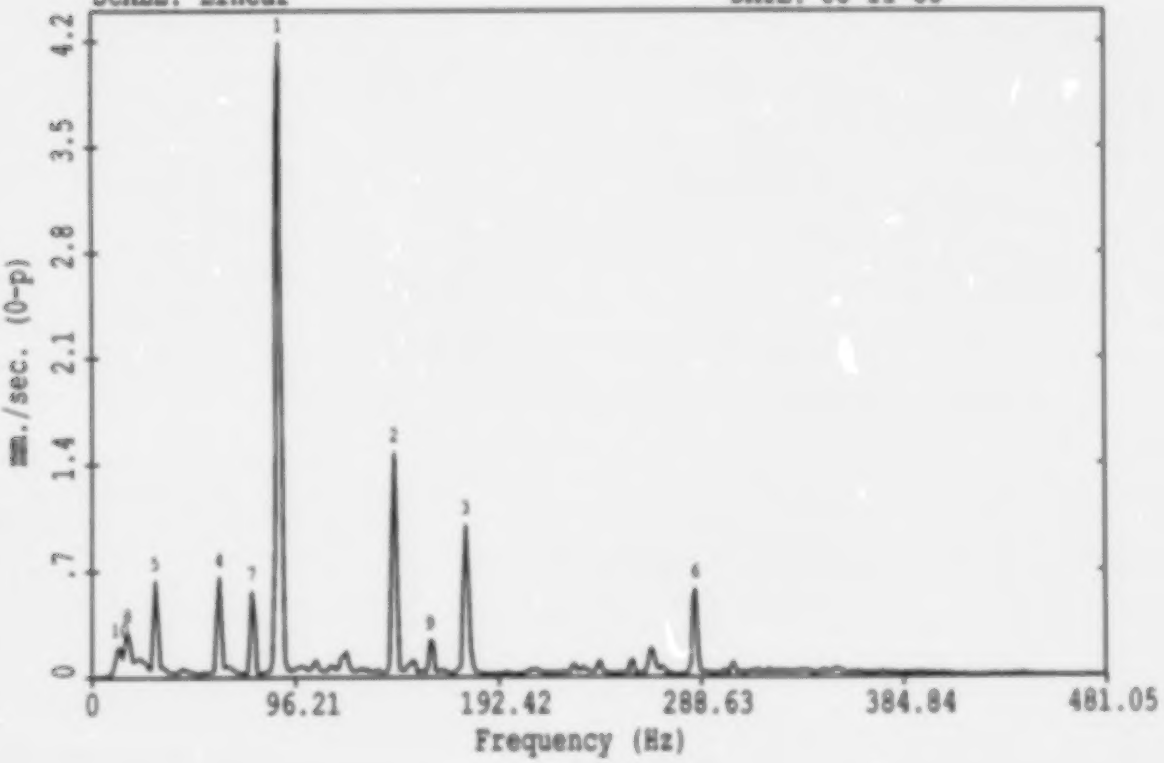
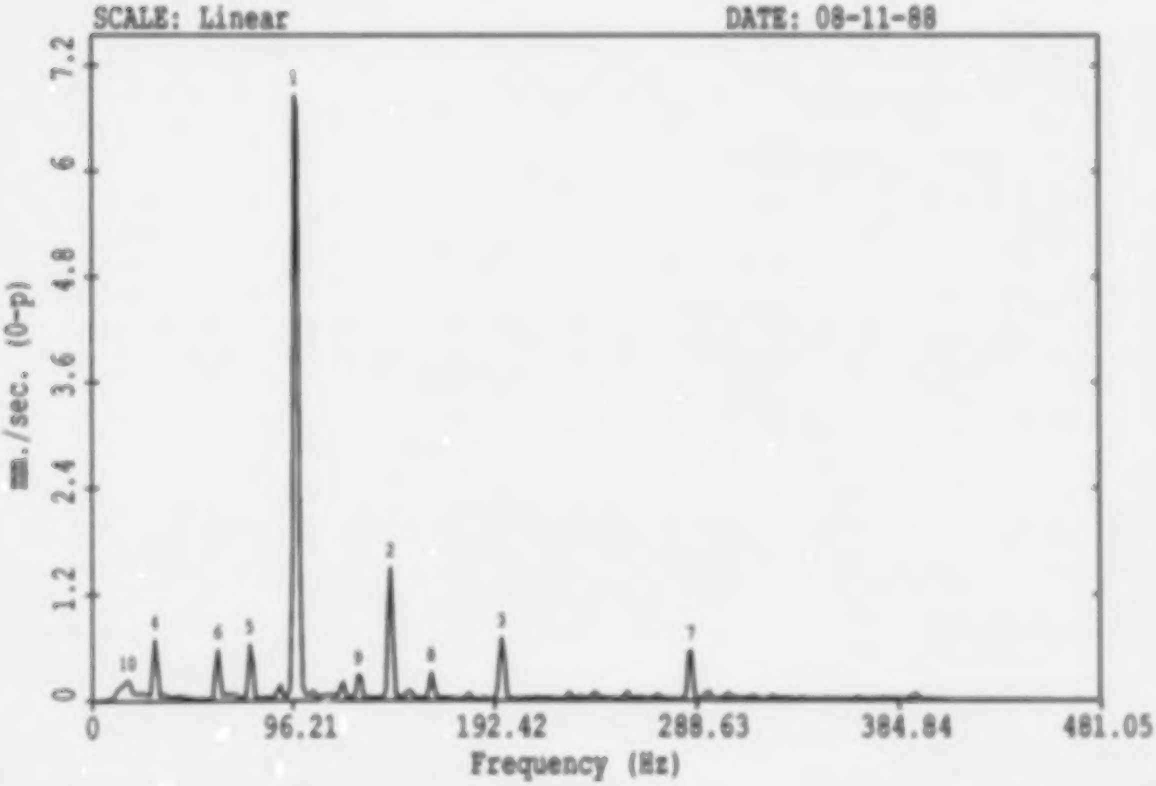


FIGURE D21

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : PT Bearing #5 Casing Velocity Axial
PROCESS CONDITION : Load 5.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 97.4 | 6.87 |
| 2 | 143.1 | 1.51 |
| 3 | 196.0 | 0.71 |
| 4 | 30.1 | 0.70 |
| 5 | 75.8 | 0.64 |
| 6 | 60.1 | 0.58 |
| 7 | 286.2 | 0.56 |
| 8 | 162.4 | 0.32 |
| 9 | 127.5 | 0.29 |
| 10 | 16.8 | 0.23 |


SCALE: Linear

DATE: 08-11-88

FIGURE D22

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : PT Bearing #5 Casing Velocity Axial
PROCESS CONDITION : Load 6.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 119.1 | 4.08 |
| 2 | 143.1 | 1.59 |
| 3 | 30.1 | 0.76 |
| 4 | 75.8 | 0.75 |
| 5 | 60.1 | 0.56 |
| 6 | 286.2 | 0.54 |
| 7 | 167.2 | 0.53 |
| 8 | 238.1 | 0.43 |
| 9 | 15.6 | 0.22 |
| 10 | 90.2 | 0.22 |

SCALE: Linear

DATE: 08-11-88

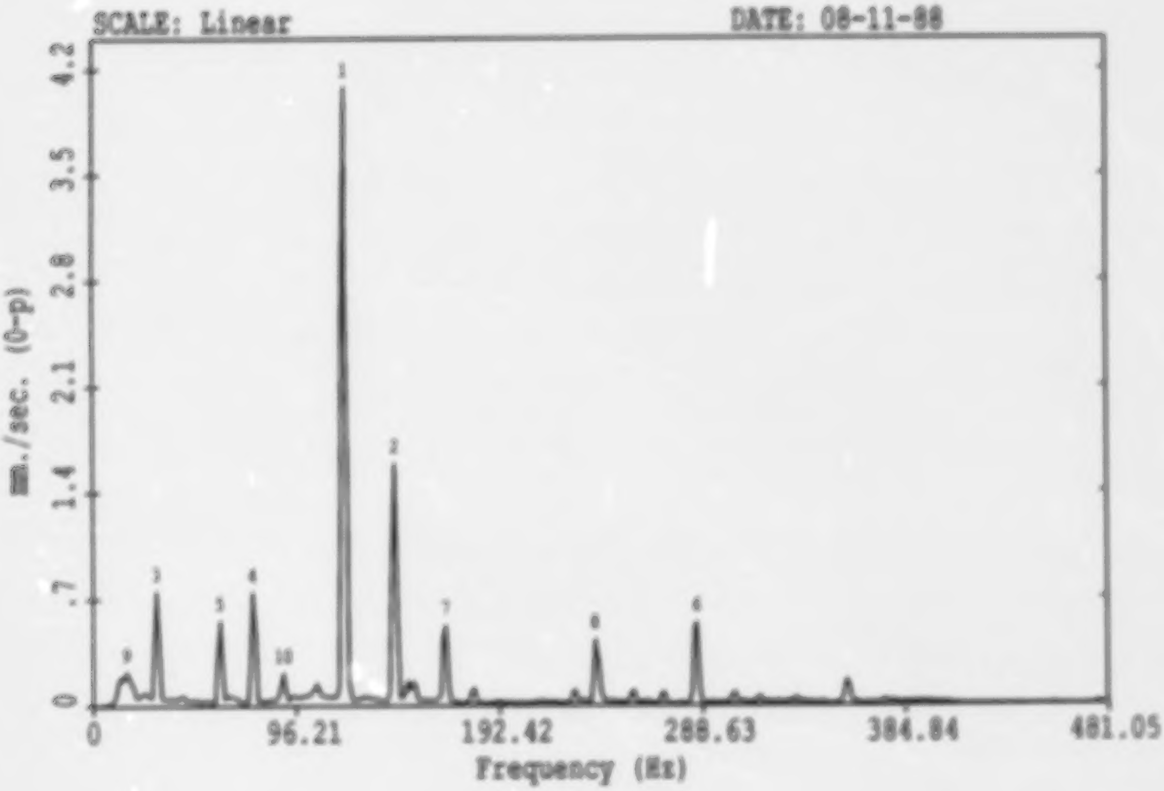


FIGURE D23

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : PT Bearing #5 Casing Velocity Axial
PROCESS CONDITION : Load 6.9 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 143.1 | 2.55 |
| 2 | 75.8 | 0.77 |
| 3 | 30.1 | 0.75 |
| 4 | 172.0 | 0.56 |
| 5 | 60.1 | 0.55 |
| 6 | 286.2 | 0.53 |
| 7 | 120.3 | 0.27 |
| 8 | 90.2 | 0.22 |
| 9 | 15.6 | 0.22 |
| 10 | 13.2 | 0.19 |

SCALE: Linear DATE: 08-11-88

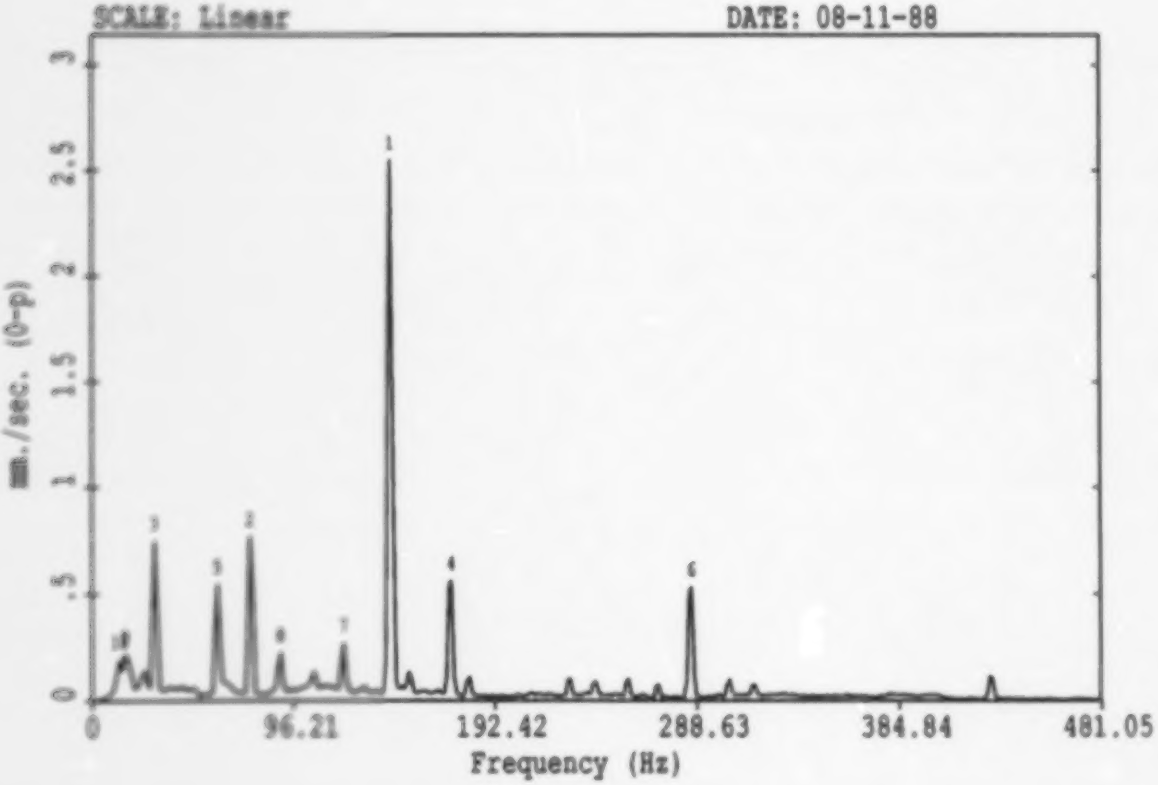


FIGURE D24

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #4 Shaft Displacement Vert.
PROCESS CONDITION : Load 0.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 143.1 | 3.90 |
| 2 | 30.1 | 2.04 |
| 3 | 147.9 | 1.51 |
| 4 | 285.0 | 1.27 |
| 5 | 428.1 | 0.83 |
| 6 | 60.1 | 0.66 |
| 7 | 14.4 | 0.63 |
| 8 | 40.9 | 0.59 |
| 9 | 2.4 | 0.52 |
| 10 | 50.5 | 0.38 |

SCALE: Linear

DATE: 08-11-88

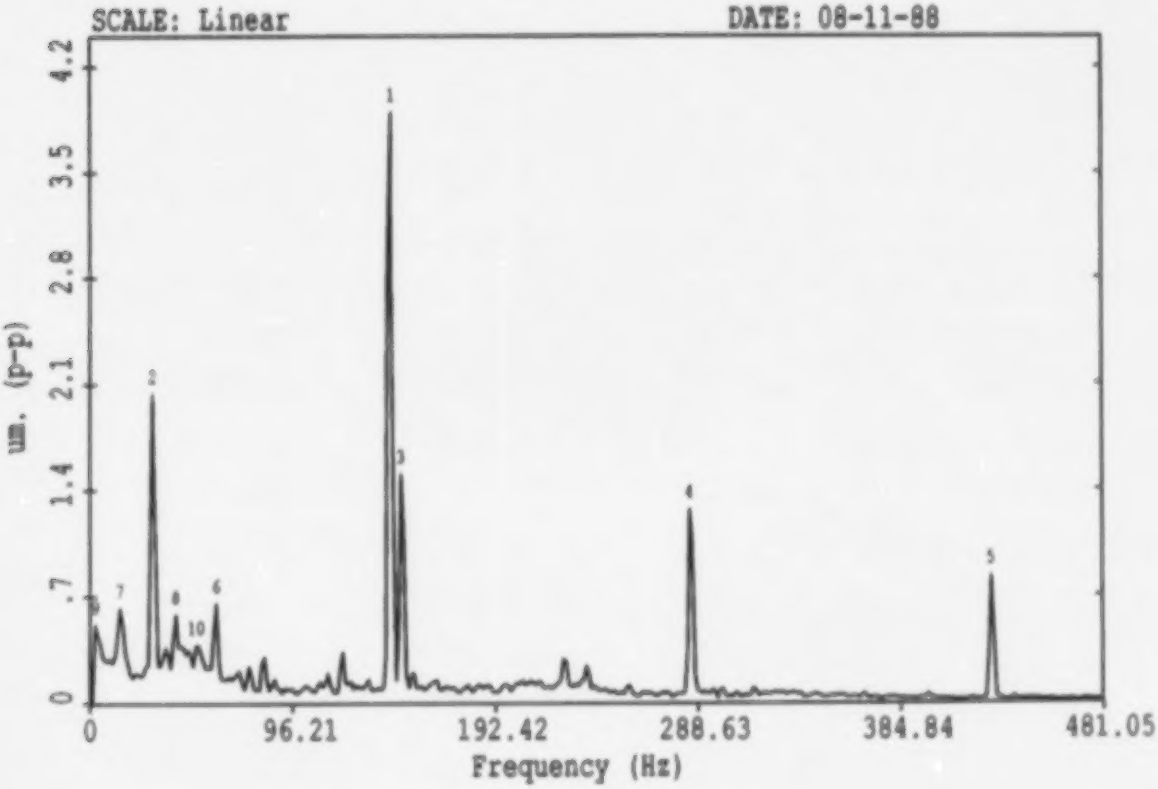


FIGURE D25

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #4 Shaft Displacement Vert.
PROCESS CONDITION : Load 1.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 143.1 | 2.61 |
| 2 | 30.1 | 1.92 |
| 3 | 2.4 | 1.33 |
| 4 | 151.5 | 1.17 |
| 5 | 50.5 | 1.07 |
| 6 | 285.0 | 1.07 |
| 7 | 75.8 | 0.91 |
| 8 | 25.3 | 0.89 |
| 9 | 428.1 | 0.86 |
| 10 | 55.3 | 0.82 |

SCALE: Linear

DATE: 08-11-88

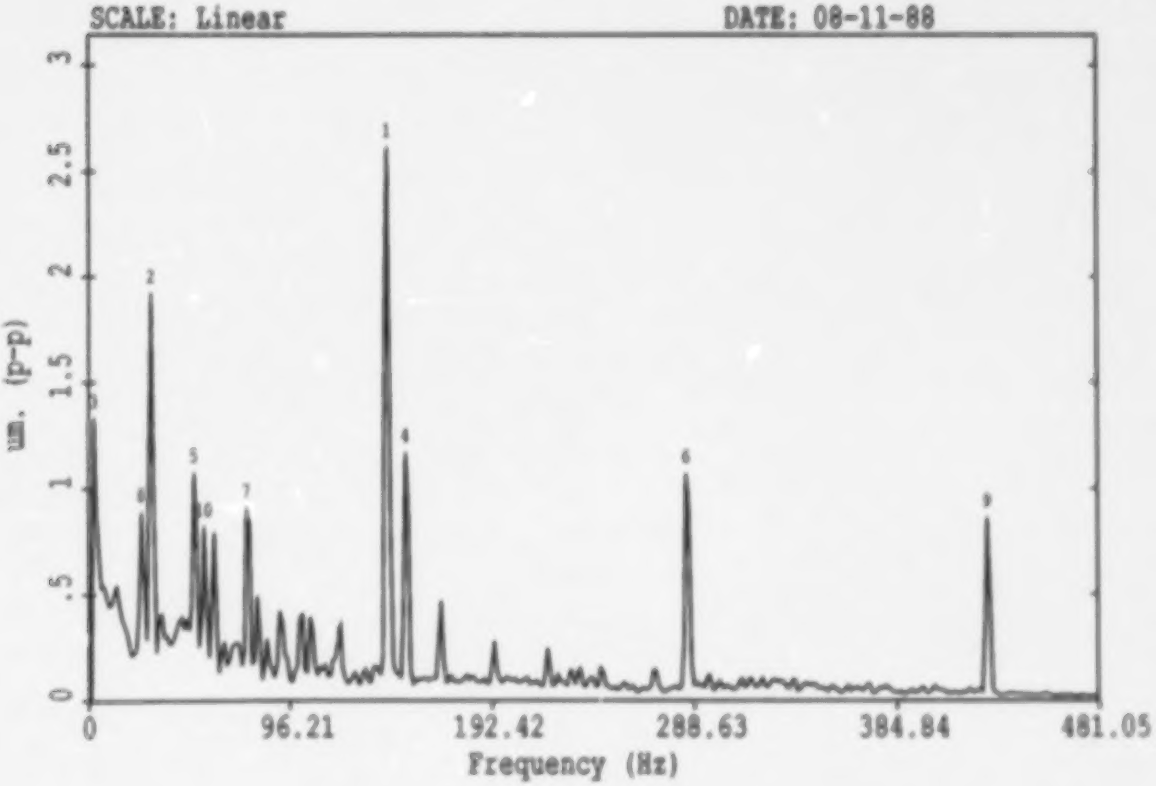


FIGURE D26

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #4 Shaft Displacement Vert.
PROCESS CONDITION : Load 2.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 4.61 |
| 2 | 60.1 | 2.76 |
| 3 | 120.3 | 1.39 |
| 4 | 14.4 | 1.28 |
| 5 | 143.1 | 1.23 |
| 6 | 155.1 | 1.14 |
| 7 | 285.0 | 1.05 |
| 8 | 428.1 | 0.84 |
| 9 | 2.4 | 0.56 |
| 10 | 43.3 | 0.56 |

SCALE: Linear

DATE: 08-11-88

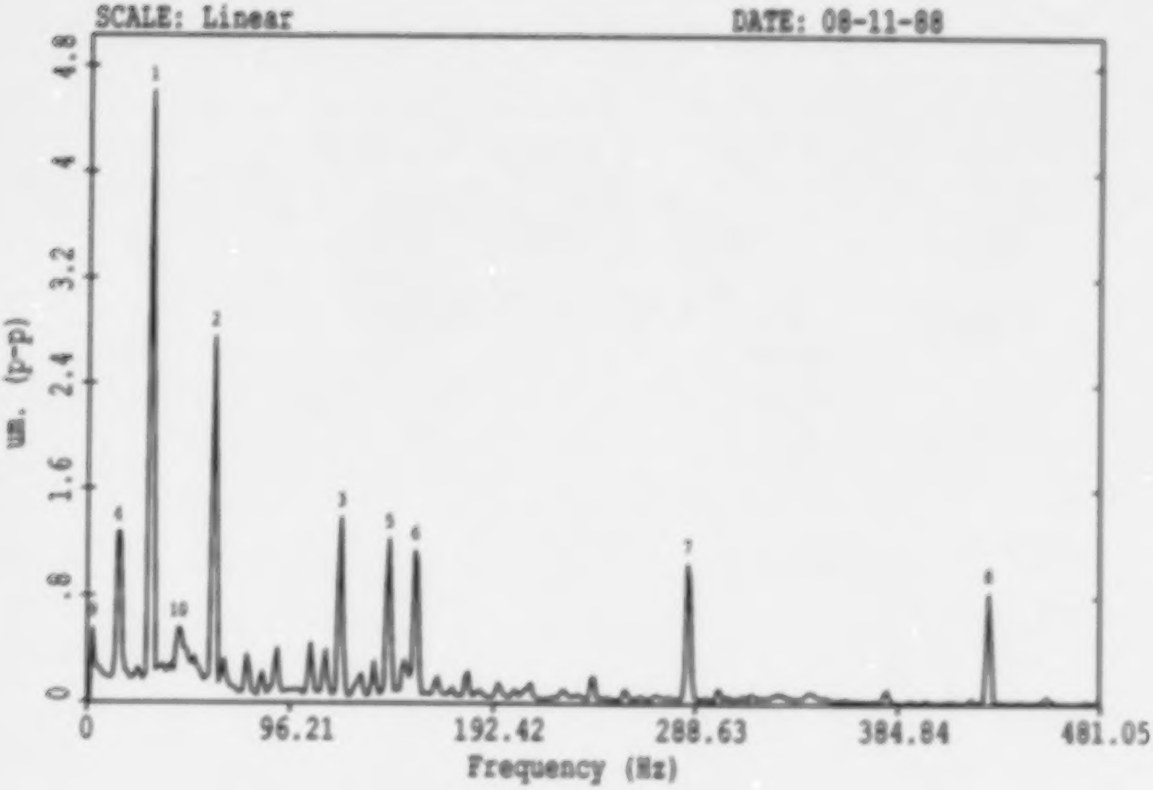
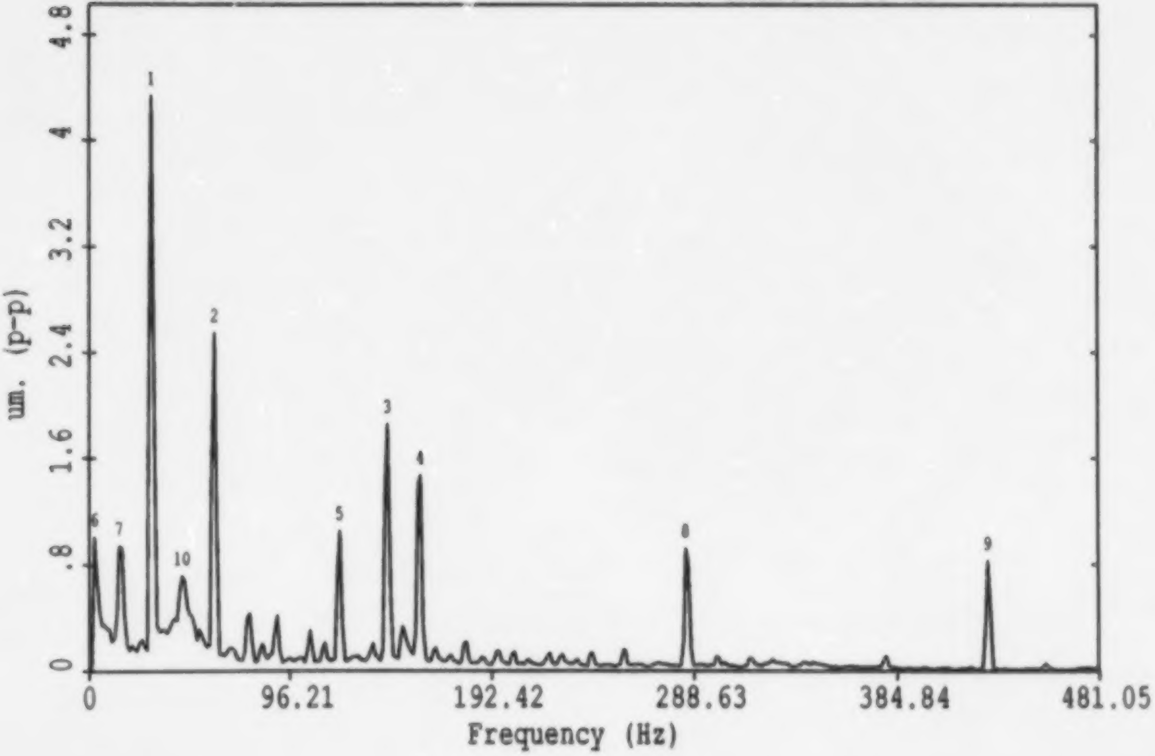


FIGURE D27

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #4 Shaft Displacement Vert.
PROCESS CONDITION : Load 3.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 4.34 |
| 2 | 60.1 | 2.55 |
| 3 | 143.1 | 1.86 |
| 4 | 158.7 | 1.47 |
| 5 | 120.3 | 1.05 |
| 6 | 2.4 | 1.01 |
| 7 | 14.4 | 0.94 |
| 8 | 285.0 | 0.93 |
| 9 | 428.1 | 0.83 |
| 10 | 44.5 | 0.72 |



SCALE: Linear DATE: 08-11-88

FIGURE D28

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #4 Shaft Displacement Vert.
PROCESS CONDITION : Load 4.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 4.30 |
| 2 | 143.1 | 2.19 |
| 3 | 60.1 | 1.82 |
| 4 | 160.0 | 1.32 |
| 5 | 120.3 | 1.05 |
| 6 | 14.4 | 0.98 |
| 7 | 428.1 | 0.84 |
| 8 | 285.0 | 0.74 |
| 9 | 44.5 | 0.56 |
| 10 | 42.1 | 0.49 |

SCALE: Linear DATE: 08-11-88

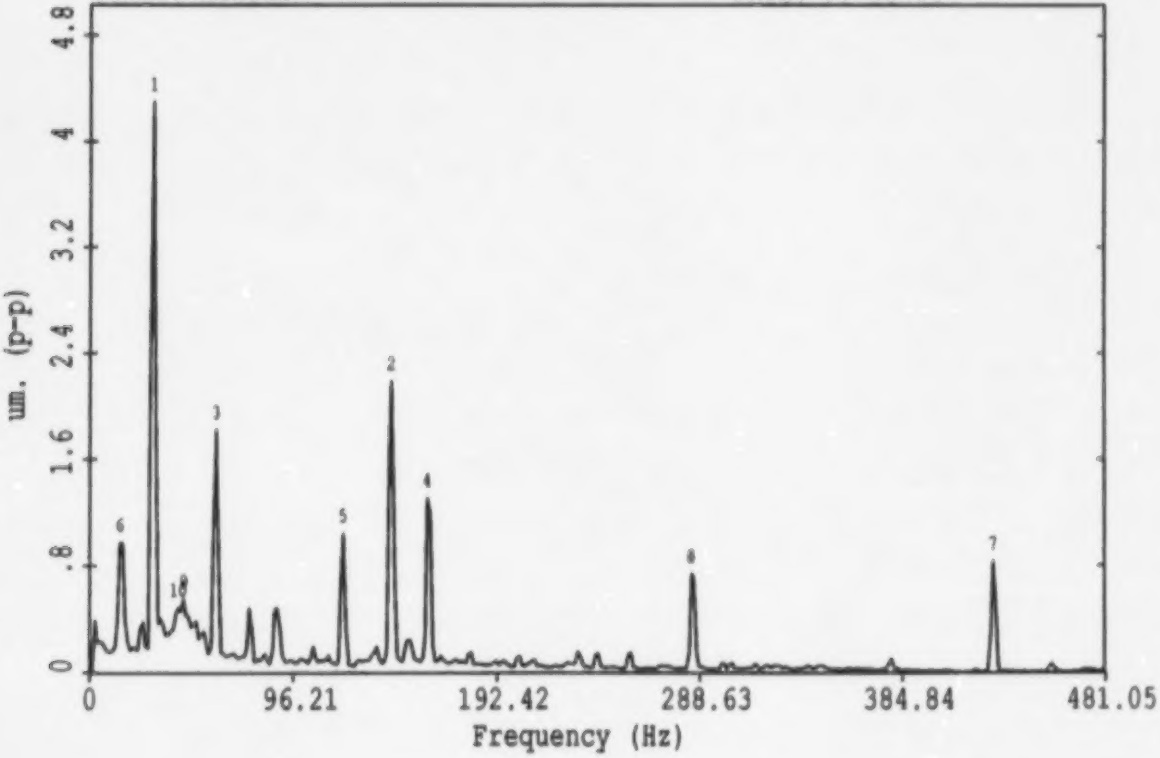


FIGURE D29

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #4 Shaft Displacement Vert.
PROCESS CONDITION : Load 5.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 4.34 |
| 2 | 143.1 | 2.05 |
| 3 | 60.1 | 1.69 |
| 4 | 162.4 | 1.24 |
| 5 | 14.4 | 1.15 |
| 6 | 120.3 | 1.07 |
| 7 | 428.1 | 0.85 |
| 8 | 98.6 | 0.67 |
| 9 | 285.0 | 0.63 |
| 10 | 75.8 | 0.59 |

SCALE: Linear

DATE: 08-11-88

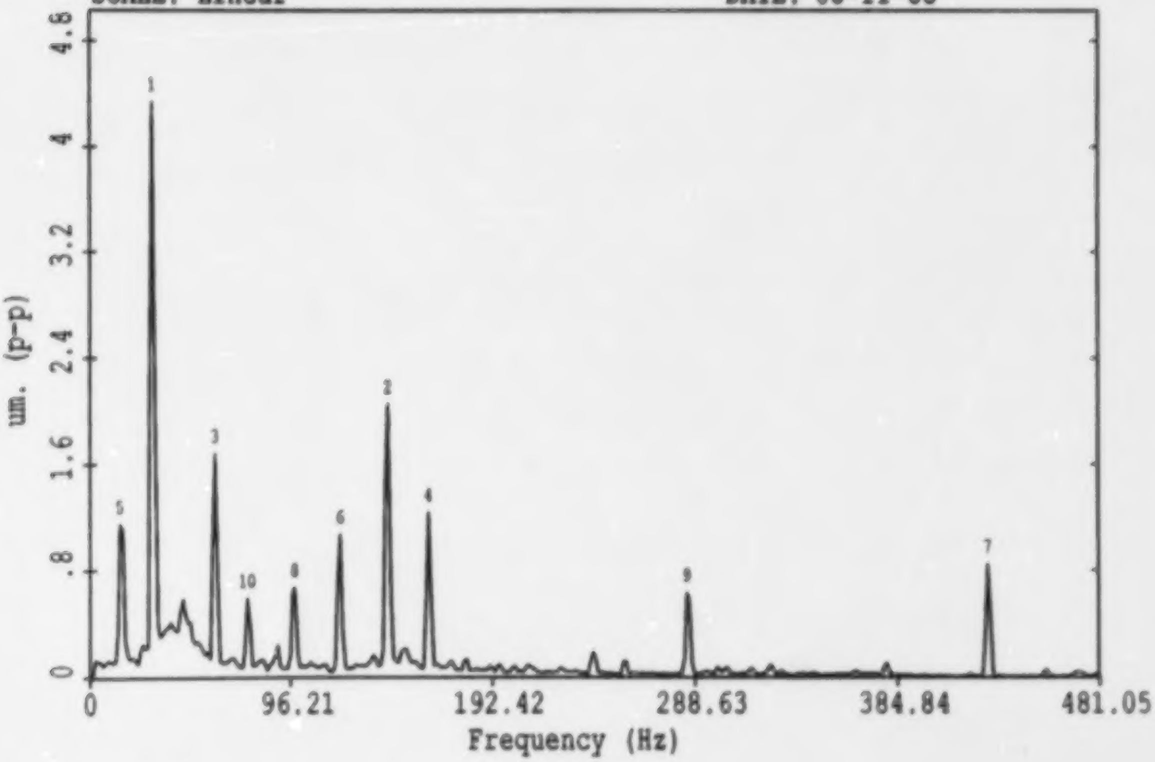


FIGURE D30

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #4 Shaft Displacement Vert.
PROCESS CONDITION : Load 6.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 4.37 |
| 2 | 143.1 | 1.92 |
| 3 | 60.1 | 1.82 |
| 4 | 14.4 | 1.17 |
| 5 | 120.3 | 1.16 |
| 6 | 428.1 | 0.85 |
| 7 | 167.2 | 0.74 |
| 8 | 75.8 | 0.71 |
| 9 | 43.3 | 0.61 |
| 10 | 285.0 | 0.57 |

SCALE: Linear DATE: 08-11-88

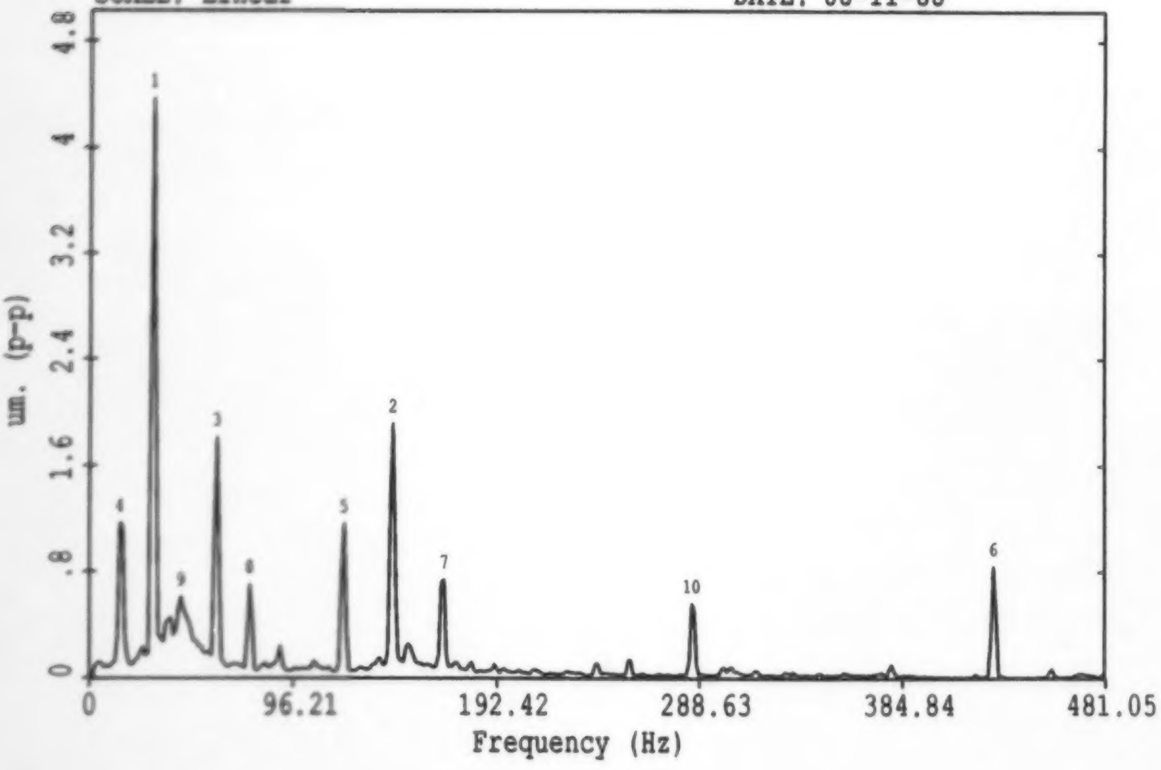


FIGURE D31

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #4 Shaft Displacement Vert.
PROCESS CONDITION : Load 6.9 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 4.57 |
| 2 | 143.1 | 2.25 |
| 3 | 60.1 | 2.06 |
| 4 | 120.3 | 1.10 |
| 5 | 75.8 | 0.88 |
| 6 | 170.8 | 0.88 |
| 7 | 428.1 | 0.84 |
| 8 | 14.4 | 0.84 |
| 9 | 42.1 | 0.71 |
| 10 | 285.0 | 0.69 |

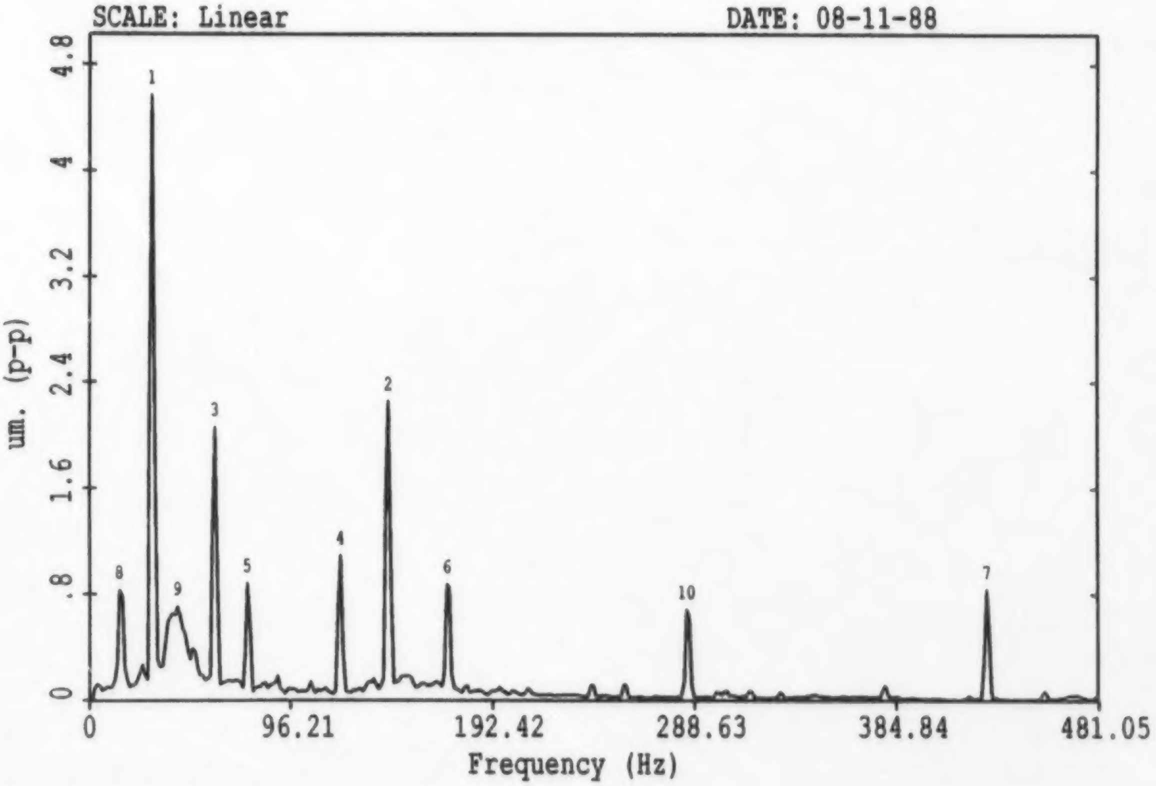


FIGURE D32

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #4 Shaft Displacement Horiz.
PROCESS CONDITION : Load 0.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 143.1 | 4.67 |
| 2 | 147.9 | 1.62 |
| 3 | 30.1 | 1.24 |
| 4 | 60.1 | 0.98 |
| 5 | 428.1 | 0.91 |
| 6 | 285.0 | 0.71 |
| 7 | 75.8 | 0.70 |
| 8 | 2.4 | 0.57 |
| 9 | 14.4 | 0.48 |
| 10 | 9.6 | 0.42 |

SCALE: Linear

DATE: 08-11-88

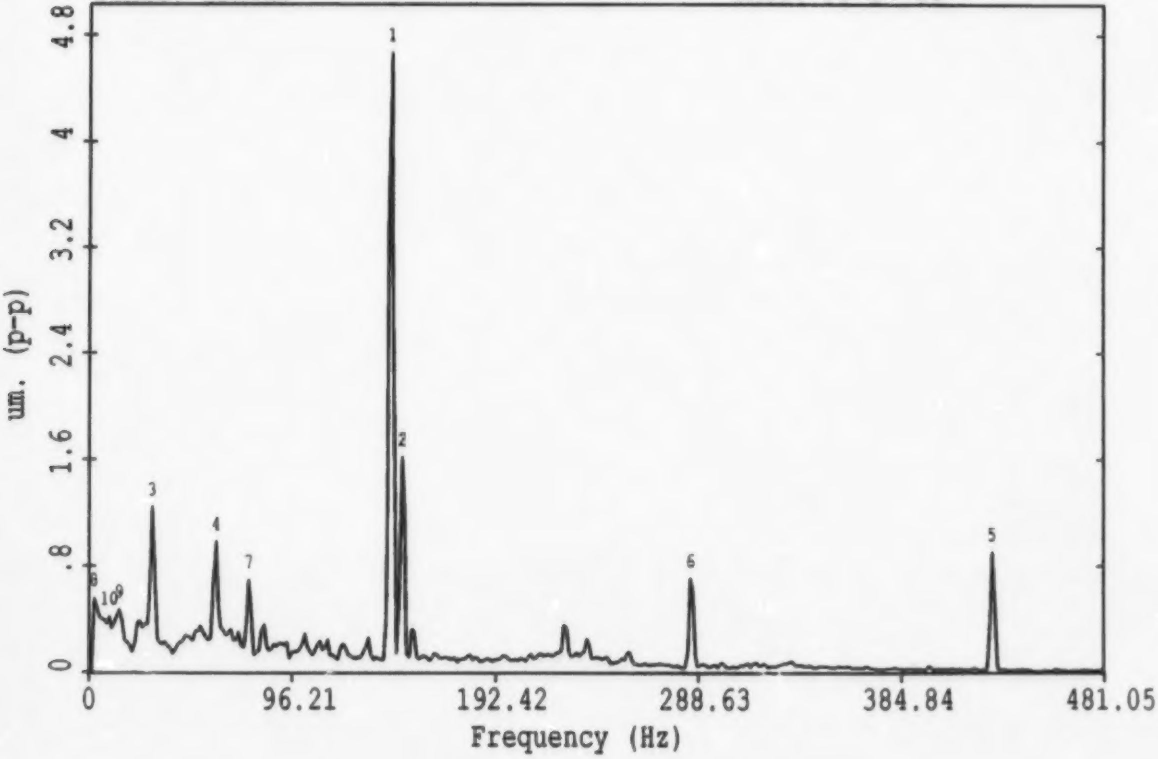


FIGURE D33

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #4 Shaft Displacement Horiz.
PROCESS CONDITION : Load 1.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 143.1 | 3.17 |
| 2 | 2.4 | 1.39 |
| 3 | 30.1 | 1.12 |
| 4 | 151.5 | 1.09 |
| 5 | 285.0 | 0.98 |
| 6 | 80.6 | 0.96 |
| 7 | 55.3 | 0.94 |
| 8 | 25.3 | 0.88 |
| 9 | 428.1 | 0.86 |
| 10 | 50.5 | 0.74 |

SCALE: Linear DATE: 08-11-88

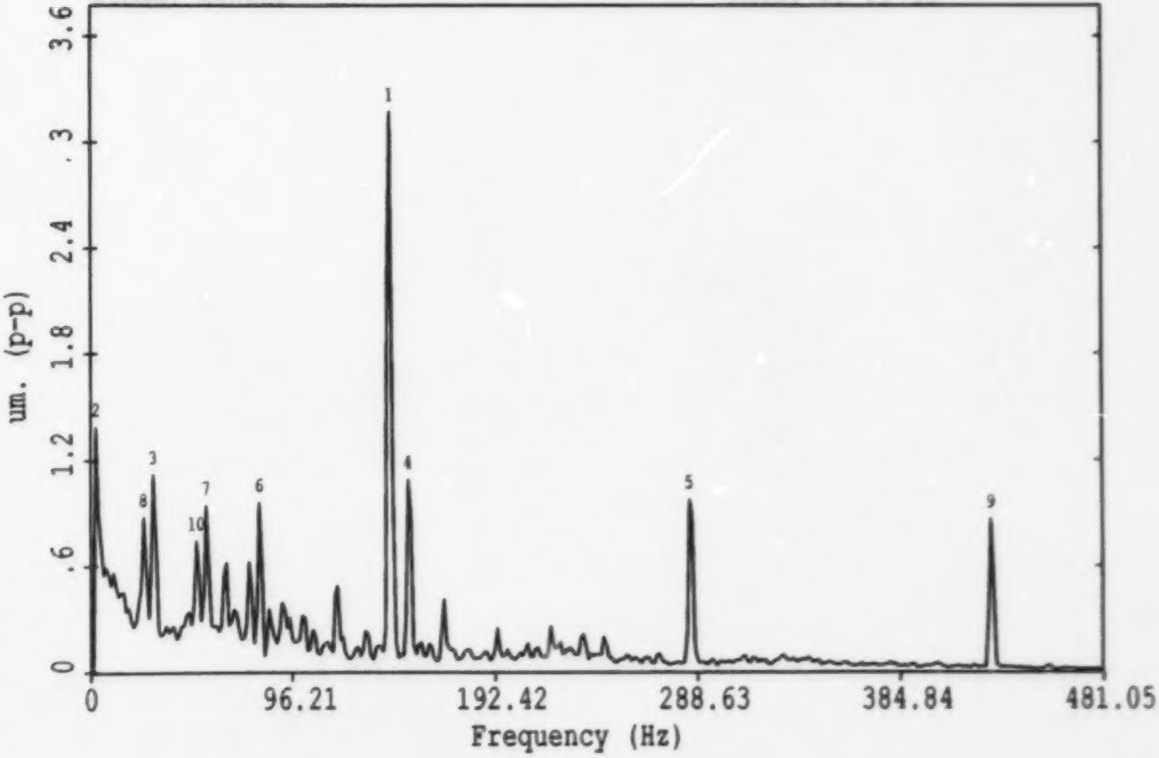


FIGURE D34

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #4 Shaft Displacement Horiz.
PROCESS CONDITION : Load 2.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 143.1 | 1.85 |
| 2 | 285.0 | 1.04 |
| 3 | 30.1 | 0.99 |
| 4 | 428.1 | 0.90 |
| 5 | 14.4 | 0.88 |
| 6 | 120.3 | 0.79 |
| 7 | 75.8 | 0.78 |
| 8 | 2.4 | 0.64 |
| 9 | 60.1 | 0.59 |
| 10 | 105.8 | 0.50 |

SCALE: Linear

DATE: 08-11-88

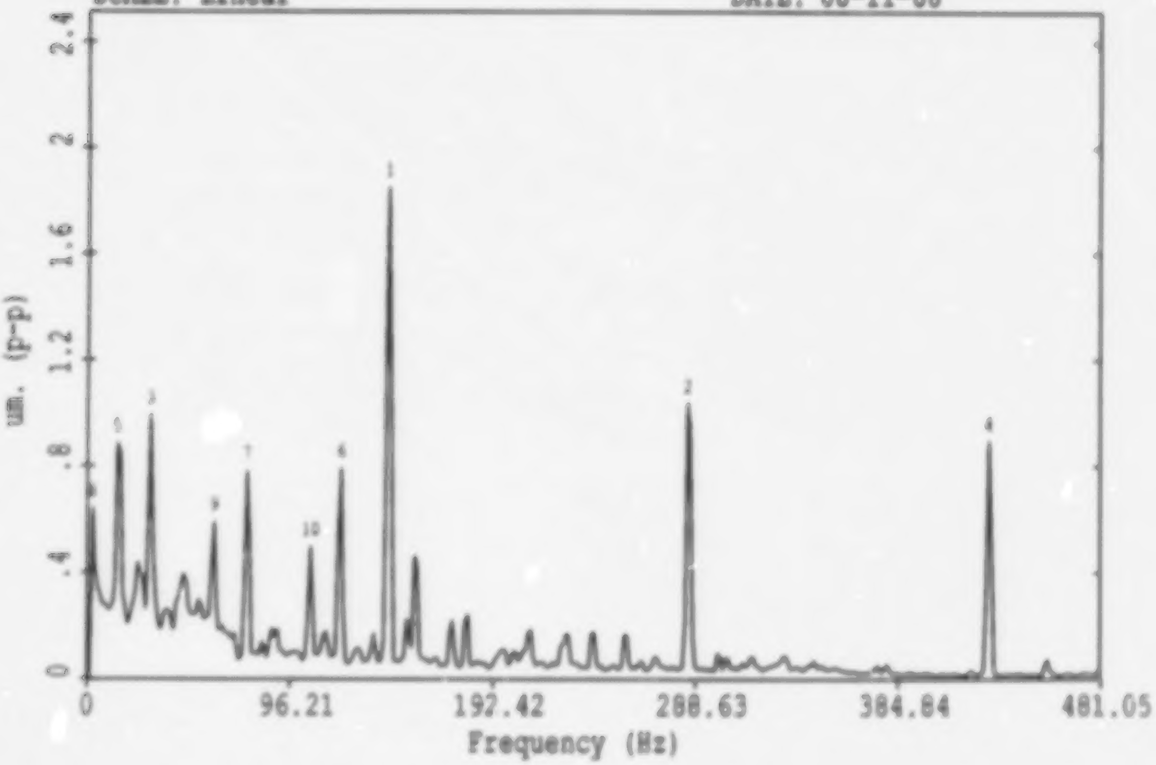


FIGURE D35

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #4 Shaft Displacement Horiz.
PROCESS CONDITION : Load 3.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 143.1 | 1.90 |
| 2 | 285.0 | 1.12 |
| 3 | 2.4 | 1.07 |
| 4 | 428.1 | 0.91 |
| 5 | 30.1 | 0.89 |
| 6 | 75.8 | 0.76 |
| 7 | 15.6 | 0.69 |
| 8 | 60.1 | 0.63 |
| 9 | 25.3 | 0.55 |
| 10 | 45.7 | 0.47 |

SCALE: Linear DATE: 08-11-88

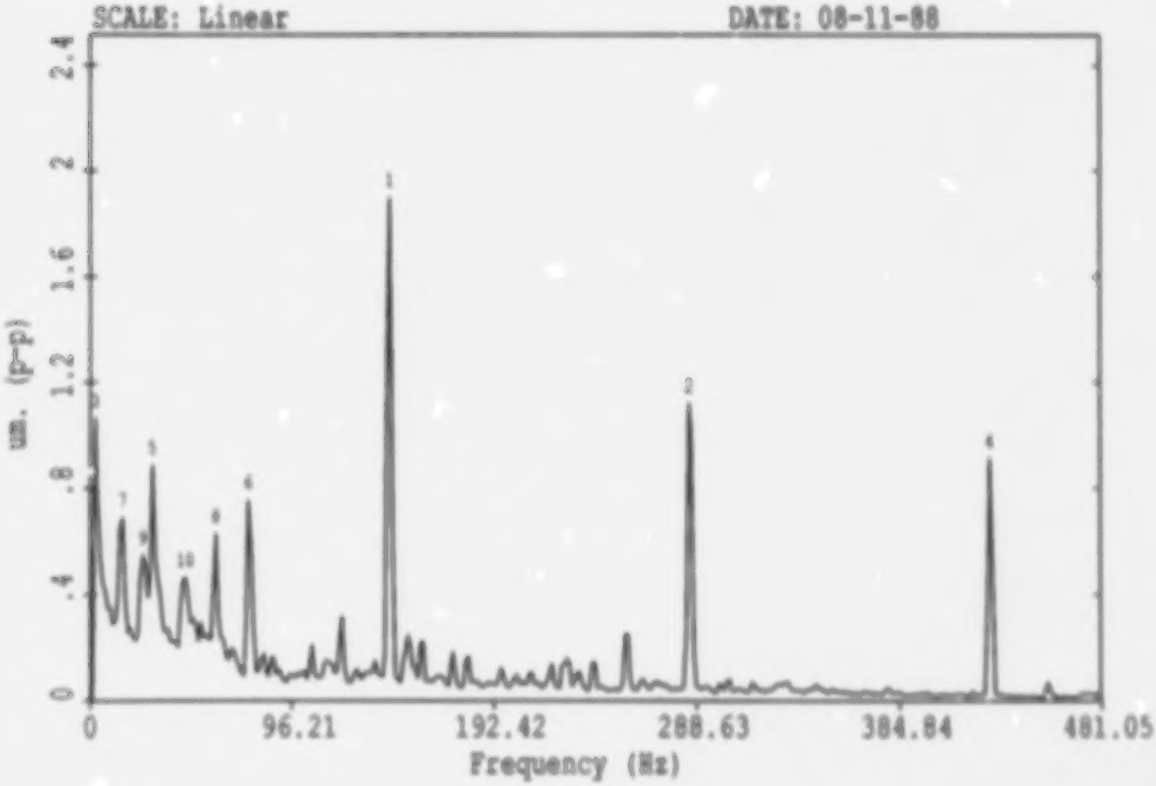


FIGURE D36

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #4 Shaft Displacement Horiz.
PROCESS CONDITION : Load 4.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 143.1 | 1.92 |
| 2 | 30.1 | 1.83 |
| 3 | 285.0 | 1.06 |
| 4 | 428.1 | 0.88 |
| 5 | 25.3 | 0.87 |
| 6 | 75.8 | 0.74 |
| 7 | 15.6 | 0.62 |
| 8 | 87.8 | 0.42 |
| 9 | 160.0 | 0.40 |
| 10 | 18.0 | 0.40 |

SCALE: Linear

DATE: 08-11-88

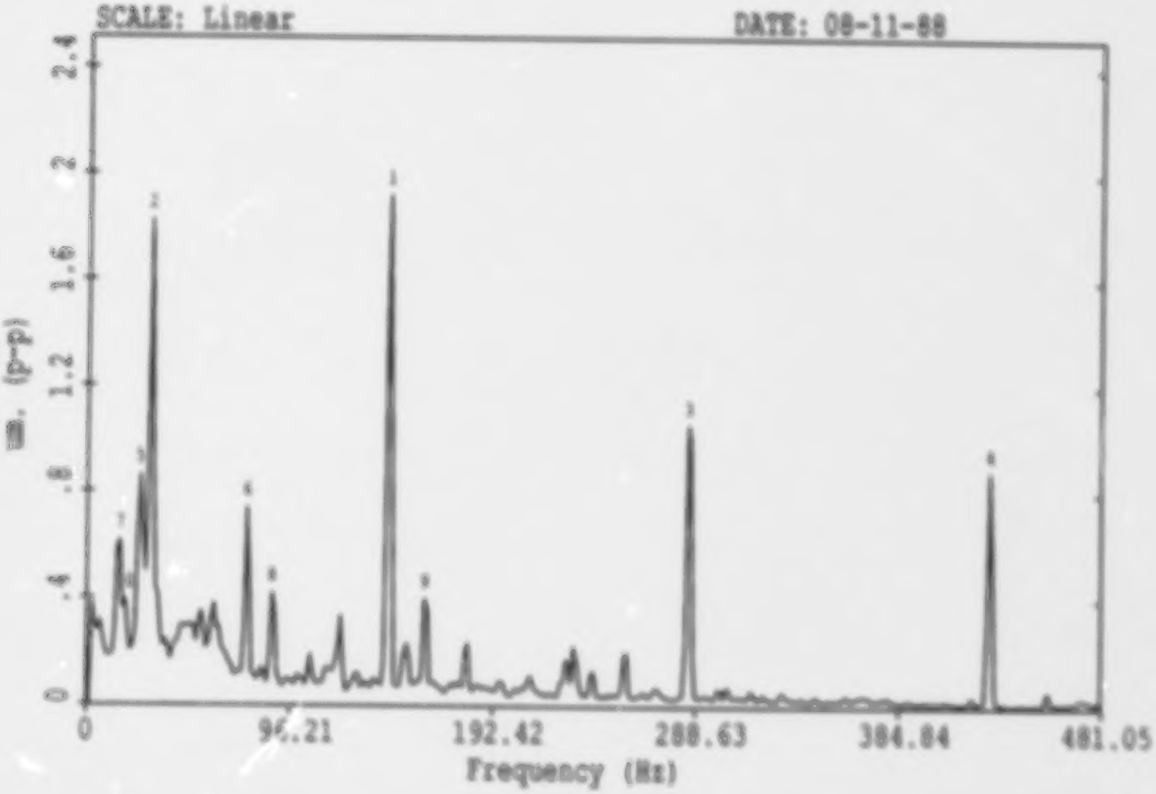


FIGURE D37

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #4 Shaft Displacement Horiz.
PROCESS CONDITION : Load 5.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 2.47 |
| 2 | 143.1 | 1.81 |
| 3 | 285.0 | 1.09 |
| 4 | 428.1 | 0.89 |
| 5 | 75.8 | 0.86 |
| 6 | 162.4 | 0.74 |
| 7 | 14.4 | 0.70 |
| 8 | 25.3 | 0.58 |
| 9 | 97.4 | 0.46 |
| 10 | 60.1 | 0.37 |

SCALE: Linear DATE: 08-11-88

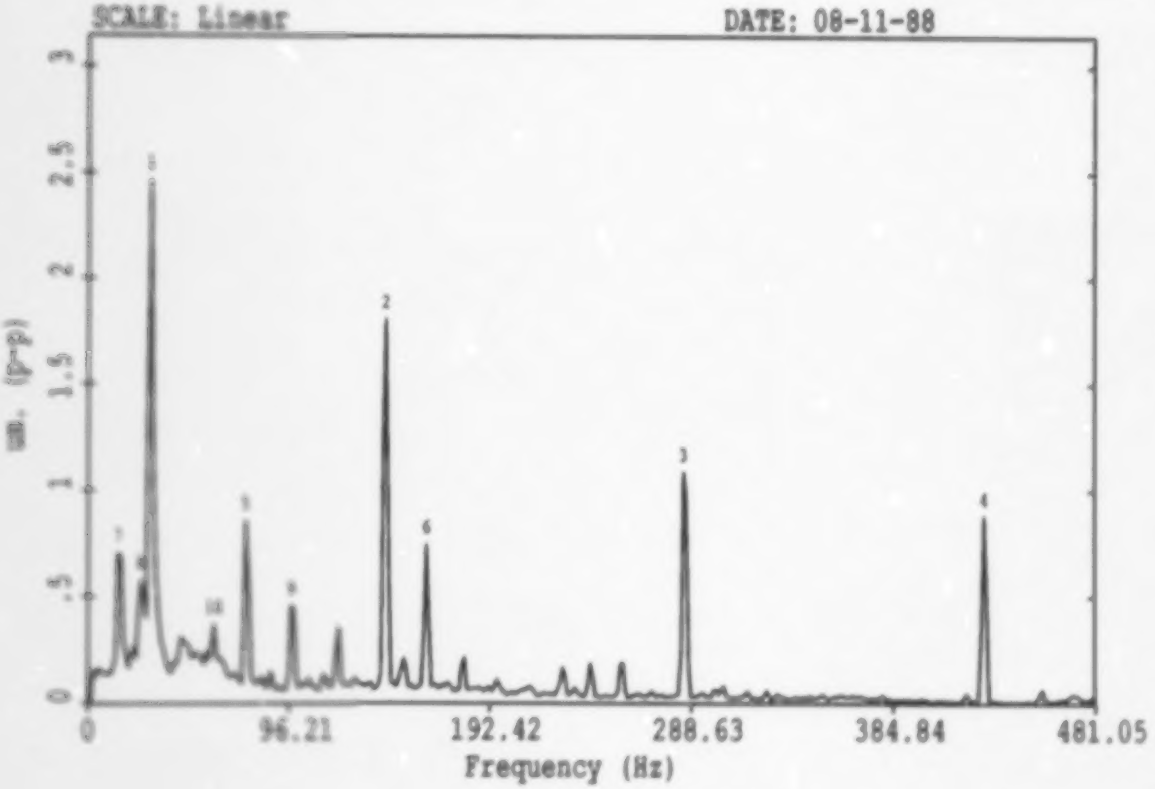


FIGURE D38

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #4 Shaft Displacement Horiz.
PROCESS CONDITION : Load 6.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 2.97 |
| 2 | 143.1 | 1.90 |
| 3 | 285.0 | 1.11 |
| 4 | 167.2 | 1.10 |
| 5 | 75.8 | 0.93 |
| 6 | 428.1 | 0.87 |
| 7 | 14.4 | 0.71 |
| 8 | 25.3 | 0.61 |
| 9 | 60.1 | 0.45 |
| 10 | 120.3 | 0.43 |

SCALE: Linear DATE: 08-11-88

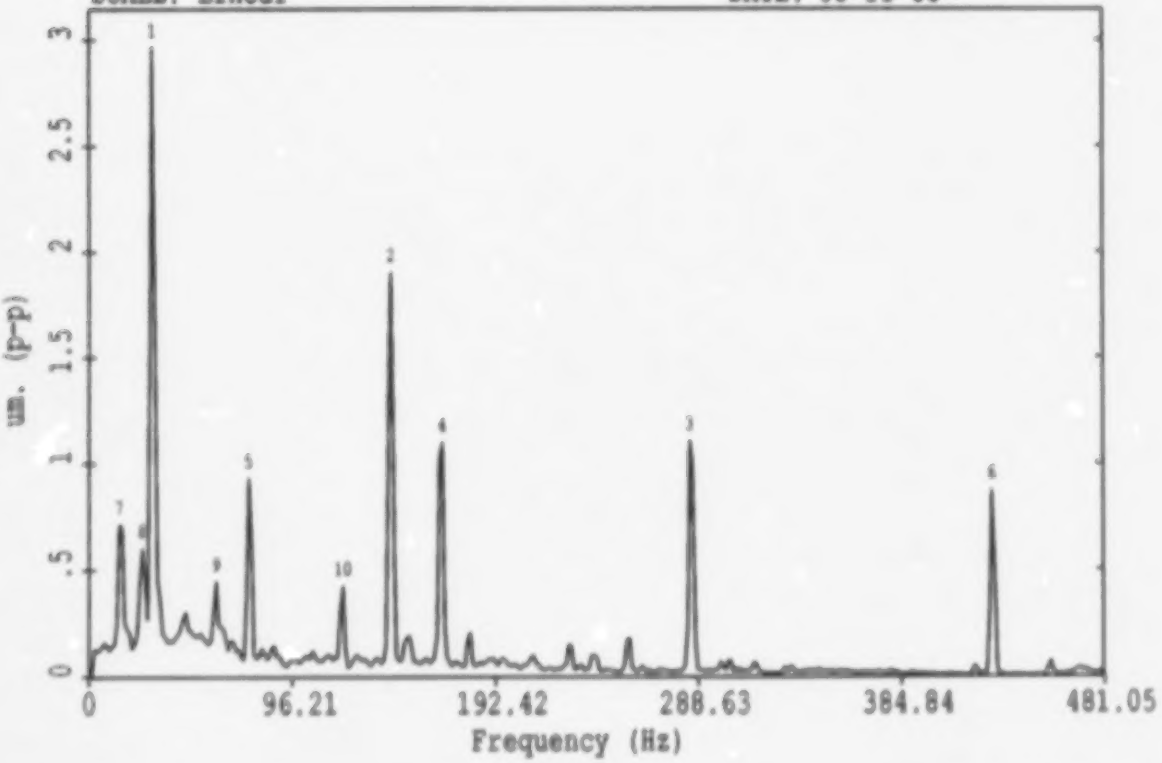
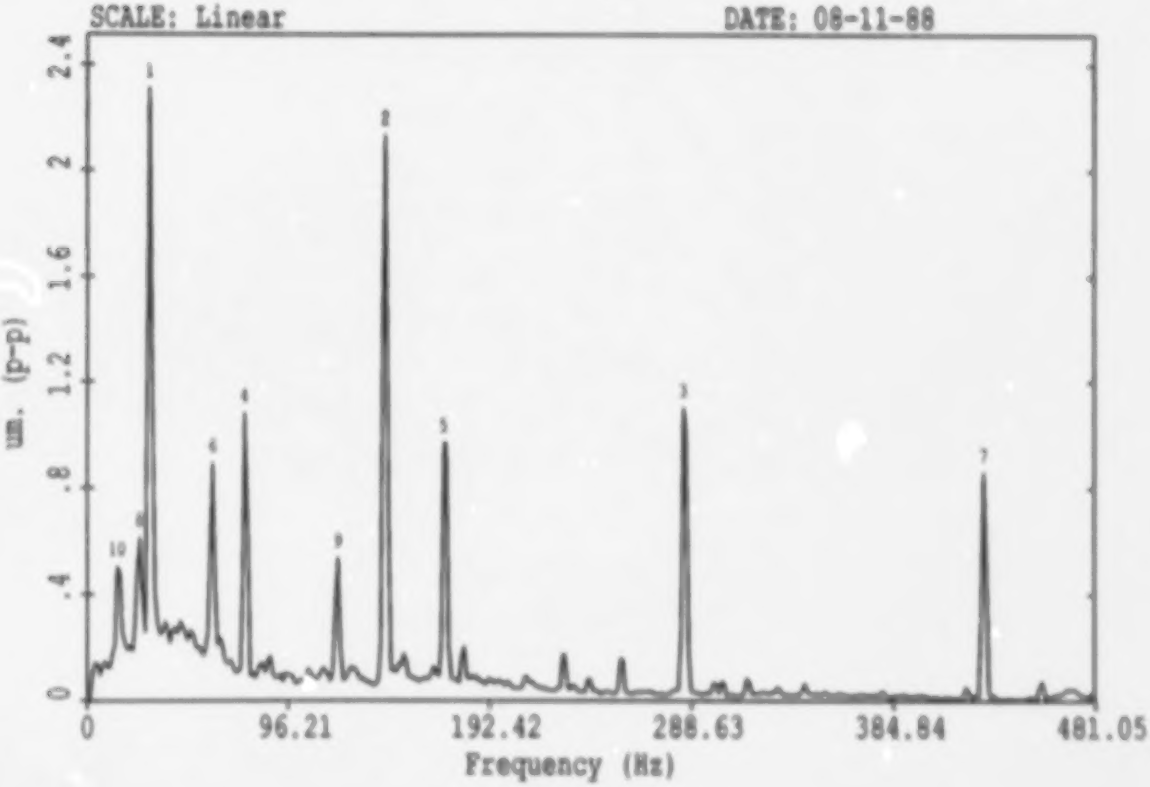


FIGURE D39

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #4 Shaft Displacement Horiz.
PROCESS CONDITION : Load 6.9 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 2.31 |
| 2 | 143.1 | 2.13 |
| 3 | 285.0 | 1.10 |
| 4 | 75.8 | 1.08 |
| 5 | 170.8 | 0.97 |
| 6 | 60.1 | 0.89 |
| 7 | 428.1 | 0.86 |
| 8 | 25.3 | 0.62 |
| 9 | 120.3 | 0.54 |
| 10 | 14.4 | 0.51 |



SCALE: Linear DATE: 08-11-88

FIGURE D40

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #5 Shaft Displacement Vert.
PROCESS CONDITION : Load 0.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 143.1 | 7.21 |
| 2 | 30.1 | 2.64 |
| 3 | 285.0 | 1.81 |
| 4 | 60.1 | 1.40 |
| 5 | 428.1 | 0.83 |
| 6 | 40.9 | 0.66 |
| 7 | 120.3 | 0.61 |
| 8 | 147.9 | 0.51 |
| 9 | 113.0 | 0.50 |
| 10 | 224.9 | 0.46 |

SCALE: Linear

DATE: 08-11-88

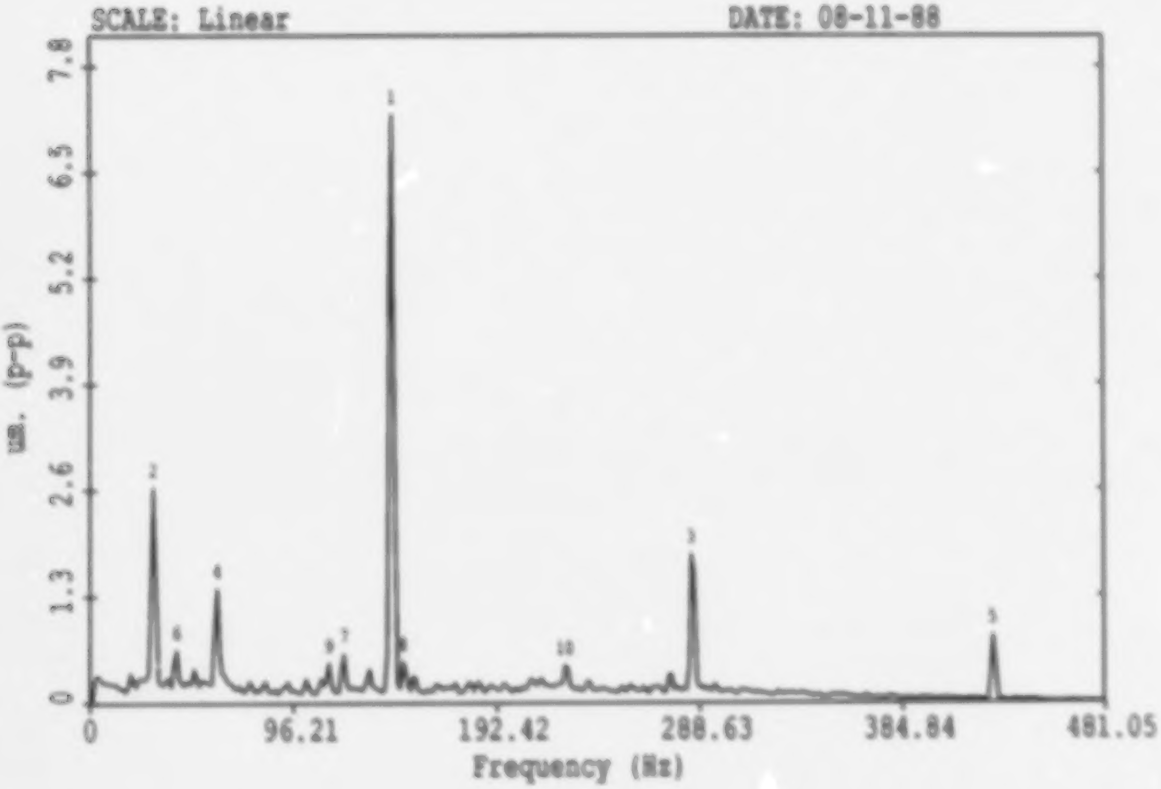


FIGURE D41

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #5 Shaft Displacement Vert.
PROCESS CONDITION : Load 1.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 143.1 | 7.31 |
| 2 | 30.1 | 2.69 |
| 3 | 55.3 | 2.08 |
| 4 | 285.0 | 2.05 |
| 5 | 25.3 | 1.67 |
| 6 | 80.6 | 1.11 |
| 7 | 168.4 | 0.94 |
| 8 | 50.5 | 0.92 |
| 9 | 2.4 | 0.87 |
| 10 | 60.1 | 0.83 |

SCALE: Linear

DATE: 08-11-88

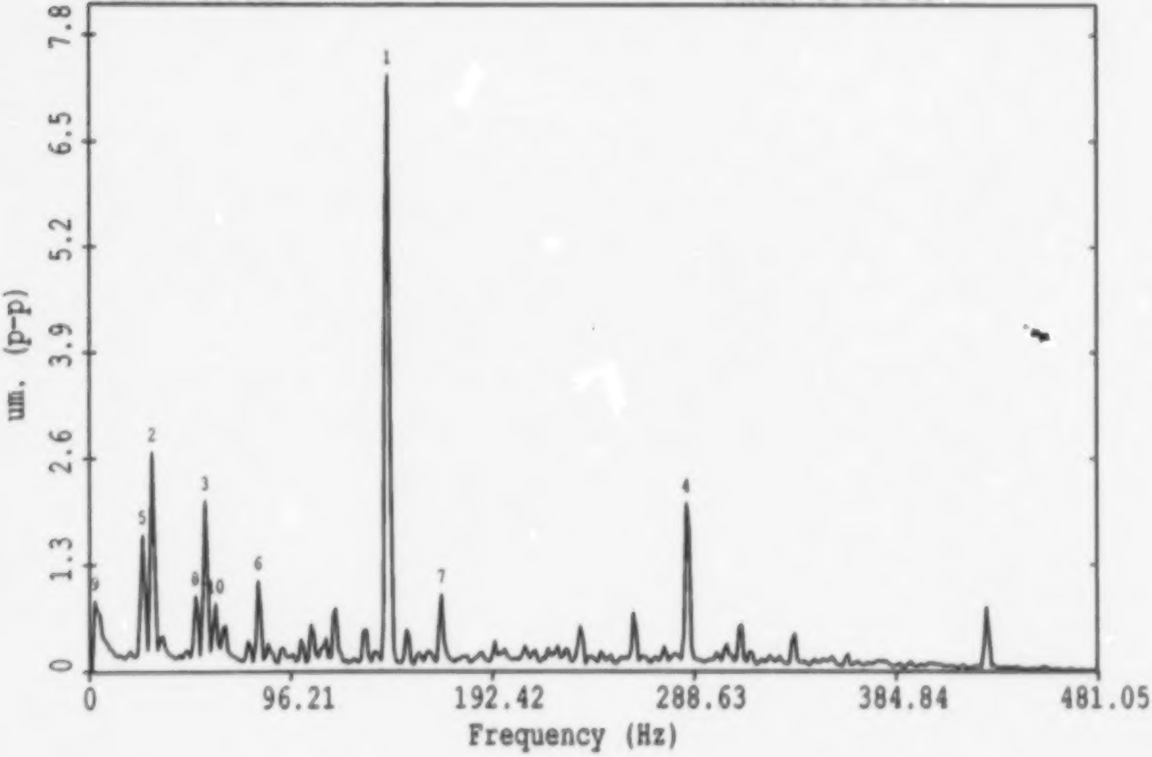


FIGURE D42

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #5 Shaft Displacement Vert.
PROCESS CONDITION : Load 2.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 143.1 | 7.16 |
| 2 | 30.1 | 5.72 |
| 3 | 60.1 | 3.02 |
| 4 | 285.0 | 2.54 |
| 5 | 120.3 | 1.20 |
| 6 | 90.2 | 0.83 |
| 7 | 428.1 | 0.81 |
| 8 | 135.9 | 0.76 |
| 9 | 75.8 | 0.67 |
| 10 | 113.0 | 0.61 |

SCALE: Linear

DATE: 08-11-88

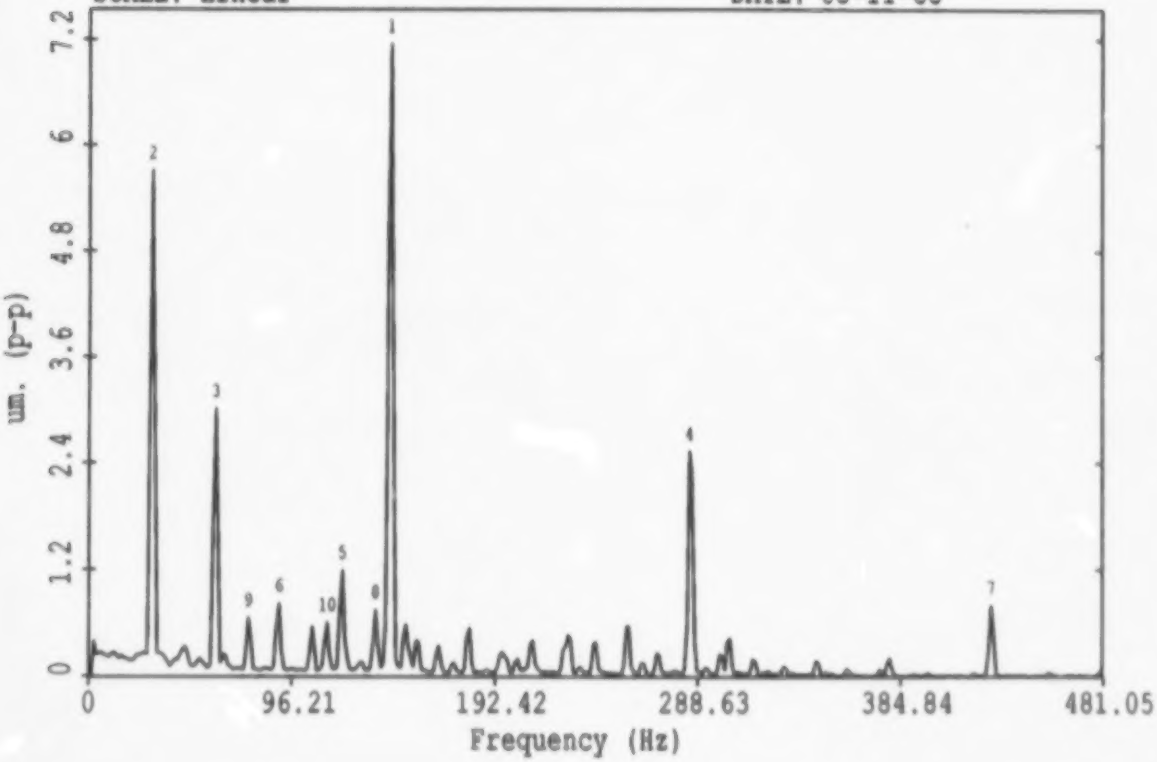


FIGURE D43

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #5 Shaft Displacement Vert.
PROCESS CONDITION : Load 3.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 143.1 | 6.43 |
| 2 | 30.1 | 6.07 |
| 3 | 60.1 | 2.50 |
| 4 | 285.0 | 2.45 |
| 5 | 120.3 | 1.36 |
| 6 | 428.1 | 0.79 |
| 7 | 90.2 | 0.72 |
| 8 | 150.3 | 0.72 |
| 9 | 75.8 | 0.62 |
| 10 | 2.4 | 0.61 |

SCALE: Linear

DATE: 08-11-88

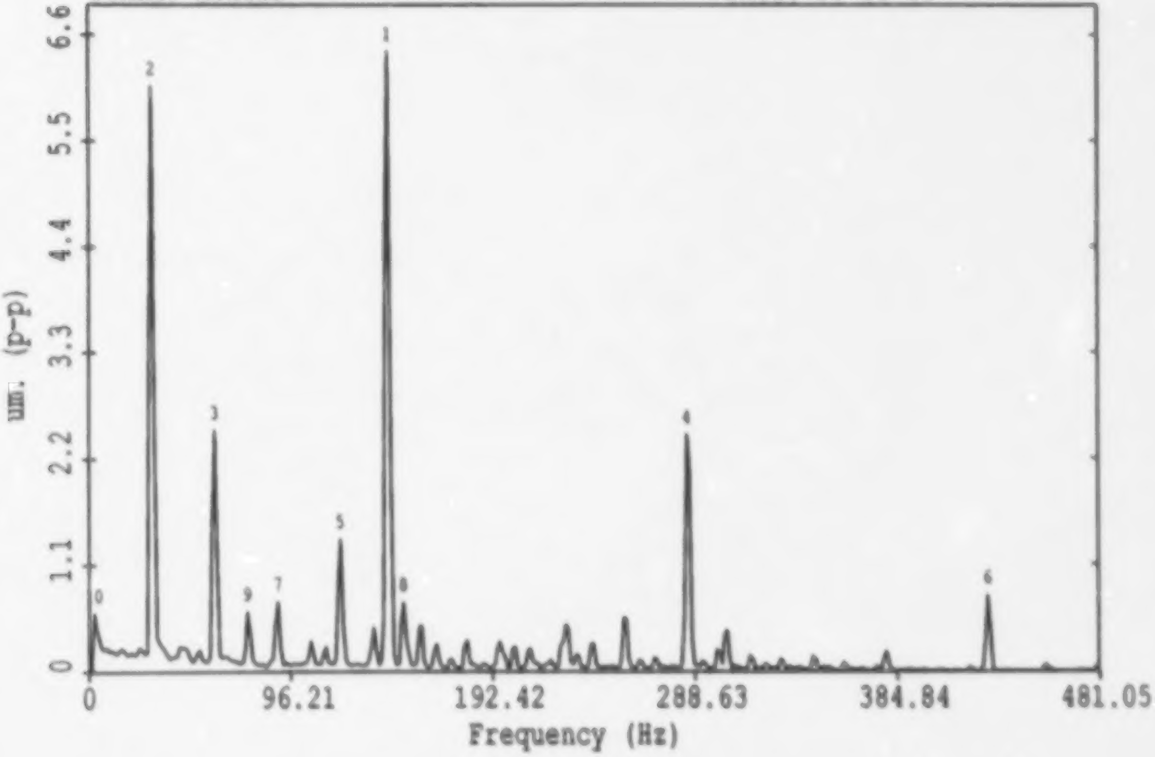


FIGURE D44

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #5 Shaft Displacement Vert.
PROCESS CONDITION : Load 4.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 143.1 | 6.33 |
| 2 | 30.1 | 6.04 |
| 3 | 285.0 | 2.56 |
| 4 | 60.1 | 1.99 |
| 5 | 120.3 | 1.28 |
| 6 | 428.1 | 0.75 |
| 7 | 75.8 | 0.65 |
| 8 | 150.3 | 0.60 |
| 9 | 227.3 | 0.47 |
| 10 | 304.3 | 0.43 |

SCALE: Linear

DATE: 08-11-88

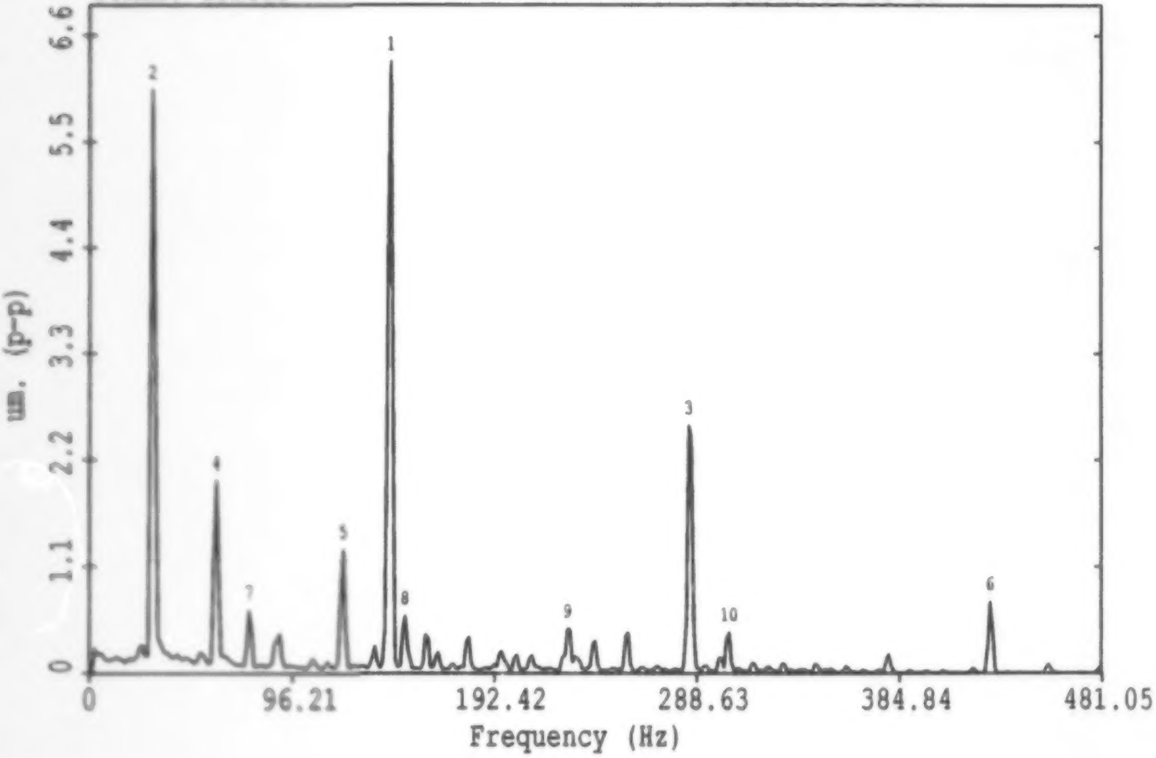


FIGURE D45

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #5 Shaft Displacement Vert.
PROCESS CONDITION : Load 5.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 6.32 |
| 2 | 143.1 | 5.93 |
| 3 | 285.0 | 2.61 |
| 4 | 60.1 | 1.69 |
| 5 | 120.3 | 1.13 |
| 6 | 428.1 | 0.74 |
| 7 | 75.8 | 0.64 |
| 8 | 150.3 | 0.49 |
| 9 | 227.3 | 0.46 |
| 10 | 97.4 | 0.46 |

SCALE: Linear DATE: 08-11-88

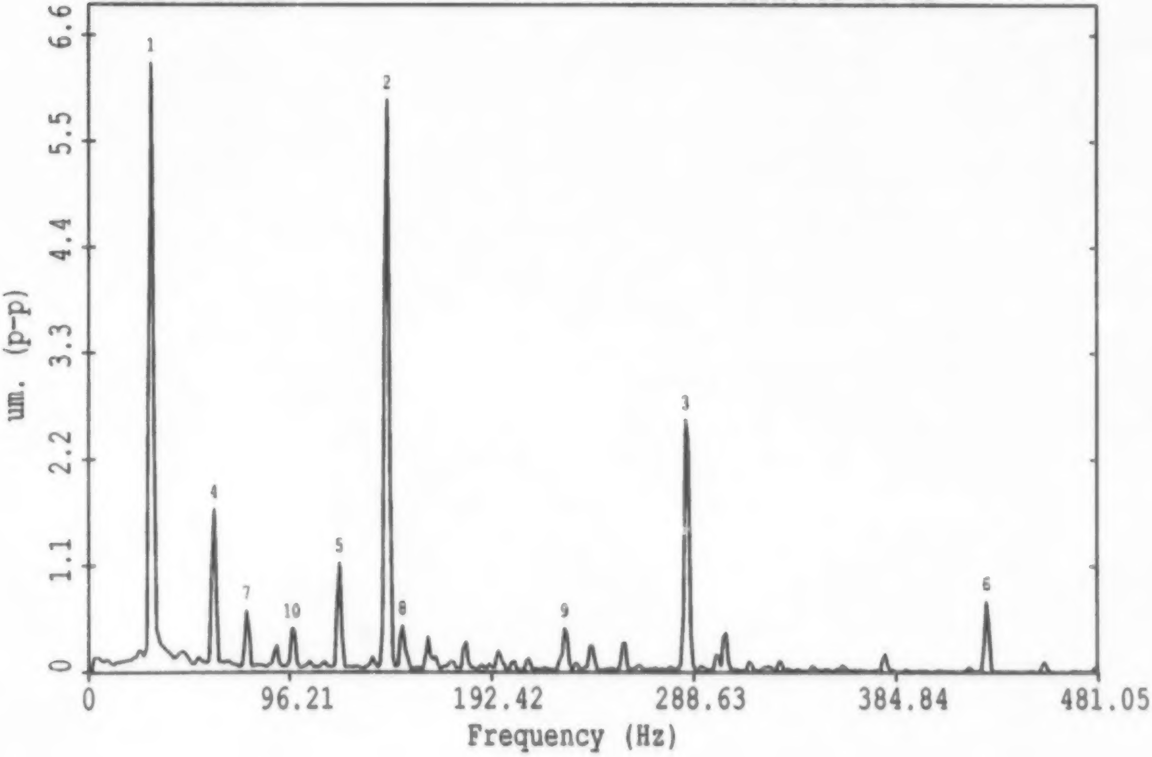


FIGURE D46

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #5 Shaft Displacement Vert.
PROCESS CONDITION : Load 6.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 6.90 |
| 2 | 143.1 | 6.11 |
| 3 | 285.0 | 2.67 |
| 4 | 60.1 | 1.65 |
| 5 | 120.3 | 1.27 |
| 6 | 428.1 | 0.72 |
| 7 | 75.8 | 0.69 |
| 8 | 150.3 | 0.53 |
| 9 | 227.3 | 0.47 |
| 10 | 304.3 | 0.43 |

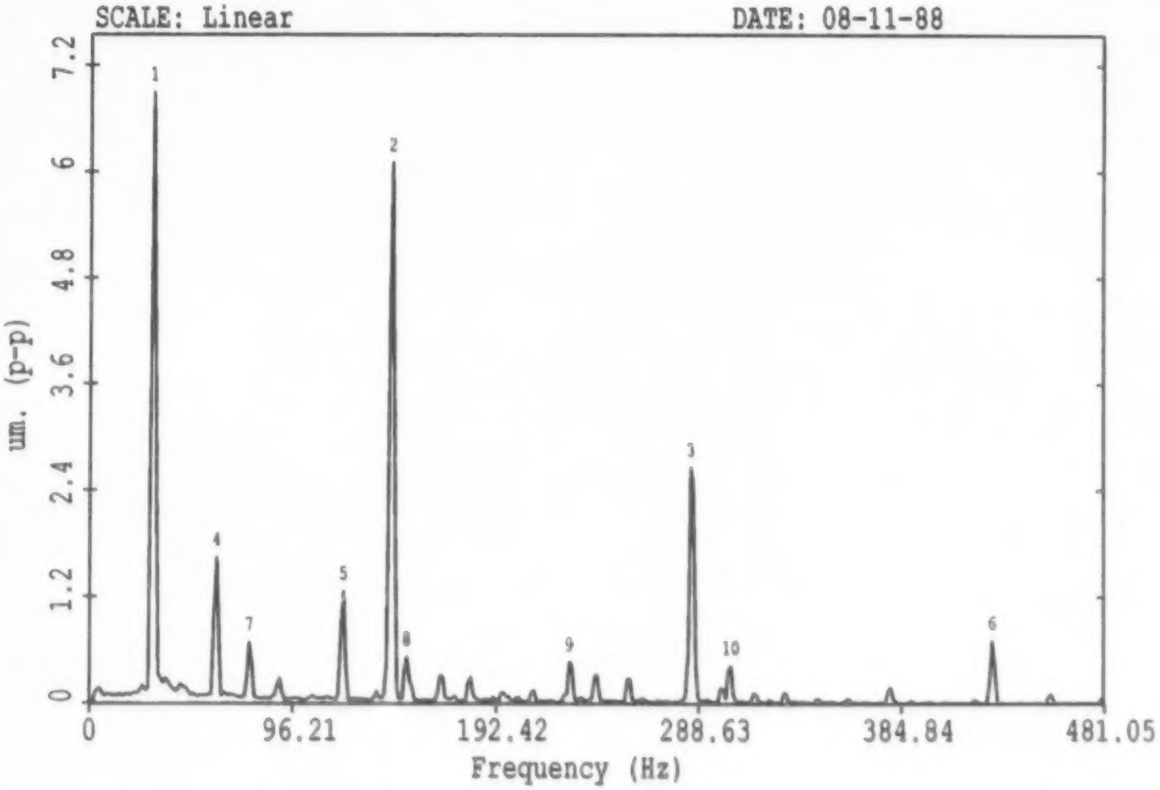


FIGURE D47

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #5 Shaft Displacement Vert.
PROCESS CONDITION : Load 6.9 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 30.1 | 6.68 |
| 2 | 143.1 | 6.39 |
| 3 | 285.0 | 2.62 |
| 4 | 60.1 | 1.56 |
| 5 | 120.3 | 1.20 |
| 6 | 428.1 | 0.73 |
| 7 | 75.8 | 0.71 |
| 8 | 227.3 | 0.53 |
| 9 | 150.3 | 0.48 |
| 10 | 304.3 | 0.42 |

SCALE: Linear

DATE: 08-11-88

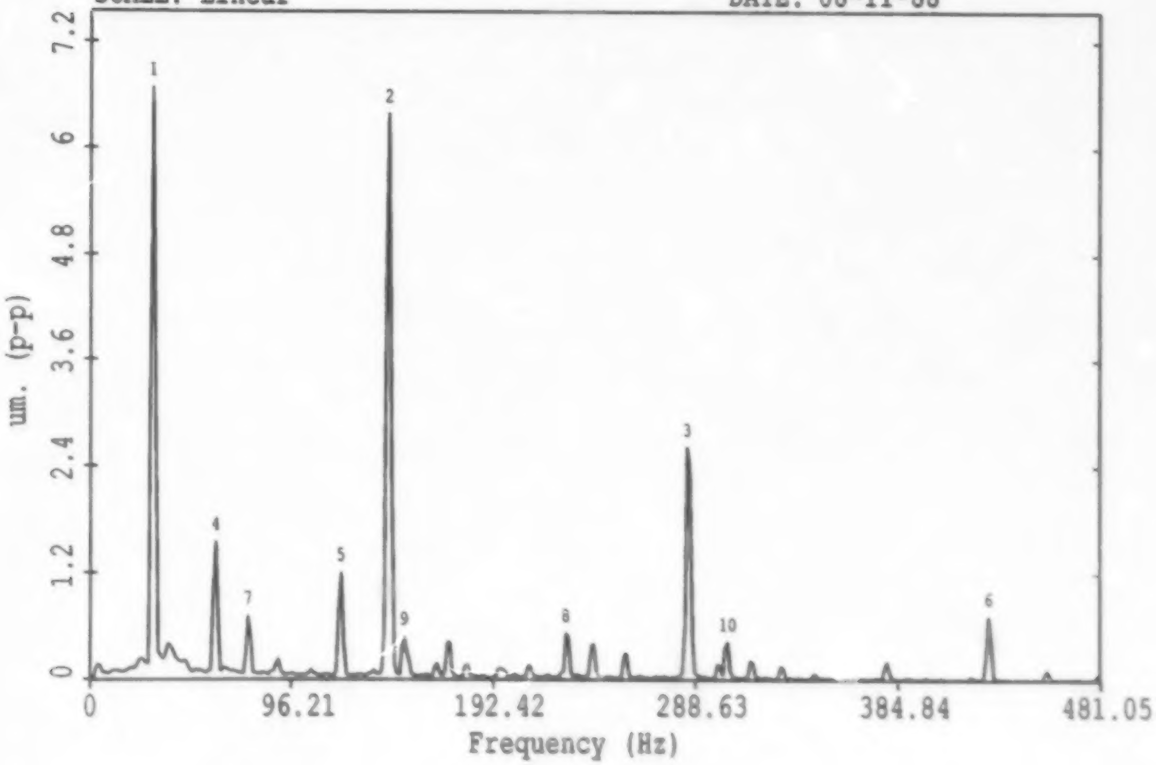


FIGURE D48

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #5 Shaft Displacement Horiz.
PROCESS CONDITION : Load 0.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 143.1 | 10.00 |
| 2 | 30.1 | 1.74 |
| 3 | 285.0 | 1.25 |
| 4 | 60.1 | 1.02 |
| 5 | 153.9 | 0.88 |
| 6 | 224.9 | 0.82 |
| 7 | 132.3 | 0.77 |
| 8 | 235.7 | 0.69 |
| 9 | 147.9 | 0.63 |
| 10 | 40.9 | 0.62 |

SCALE: Linear

DATE: 08-11-88

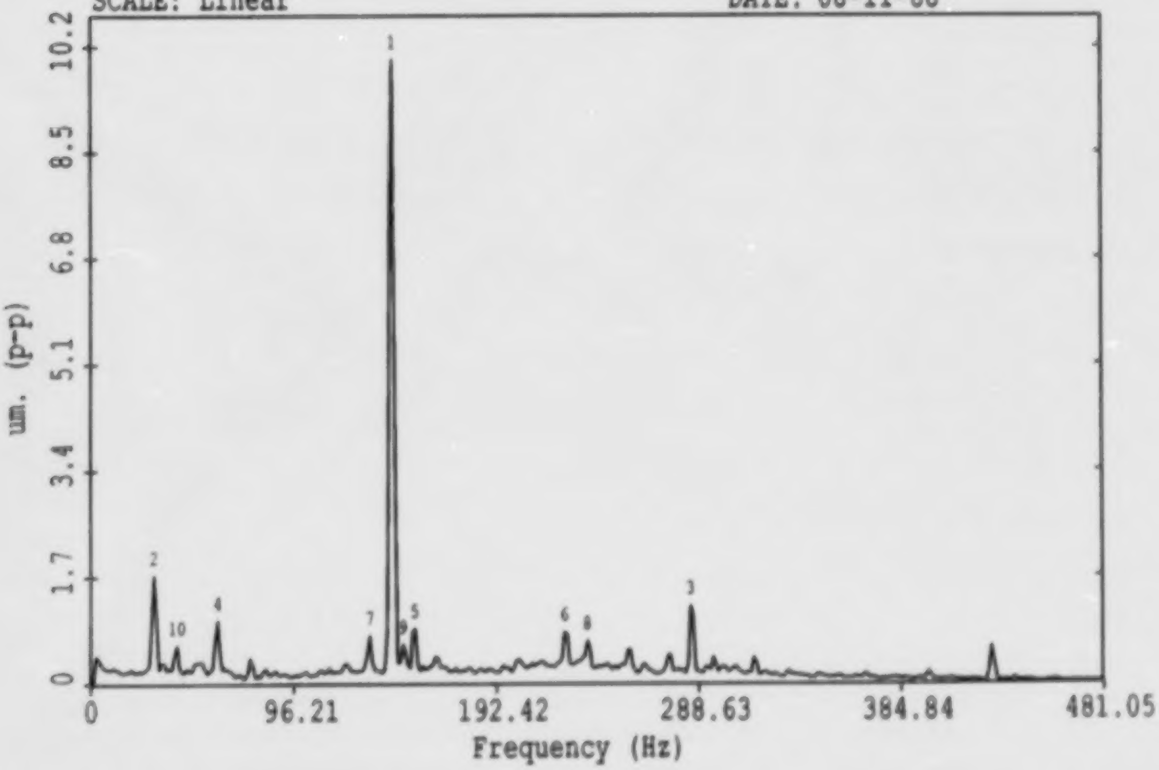


FIGURE D49

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #5 Shaft Displacement Horiz.
PROCESS CONDITION : Load 1.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 143.1 | 9.68 |
| 2 | 60.1 | 2.01 |
| 3 | 30.1 | 1.85 |
| 4 | 55.3 | 1.55 |
| 5 | 168.4 | 1.42 |
| 6 | 2.4 | 1.36 |
| 7 | 50.5 | 1.30 |
| 8 | 75.8 | 1.13 |
| 9 | 117.9 | 1.09 |
| 10 | 25.3 | 1.05 |

SCALE: Linear

DATE: 08-11-88

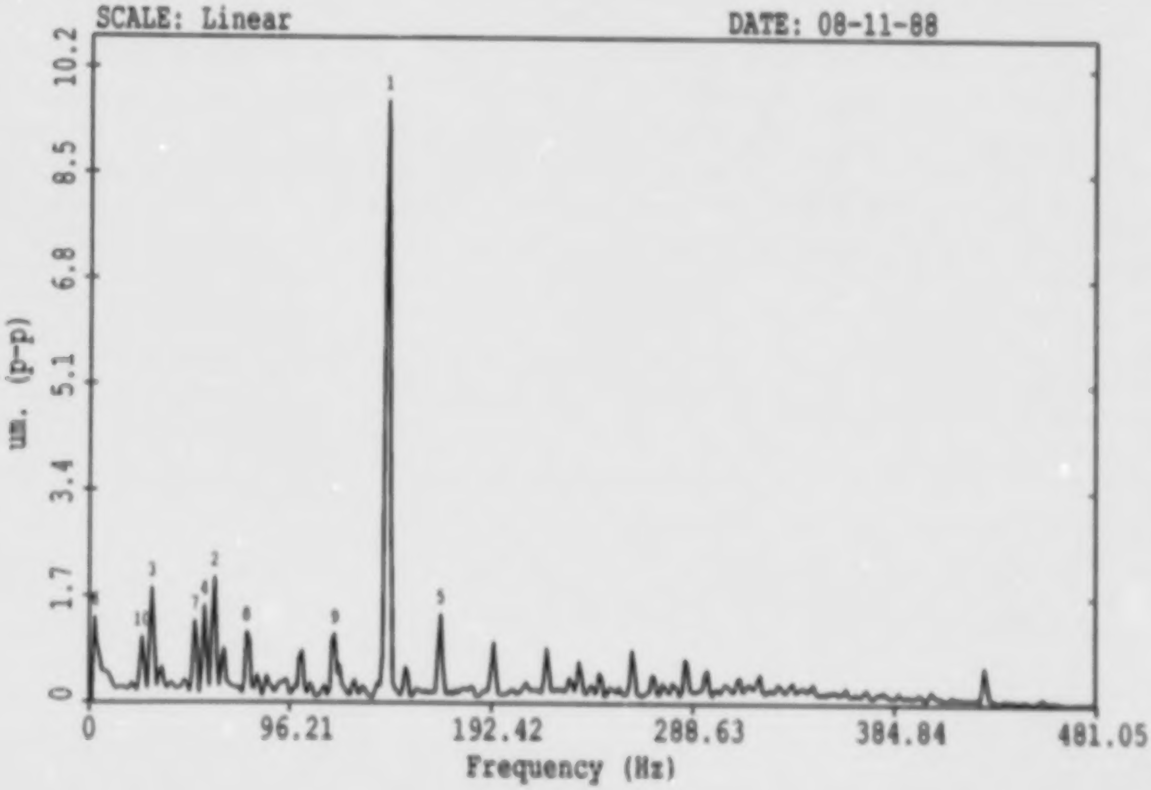


FIGURE D50

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #5 Shaft Displacement Horiz.
PROCESS CONDITION : Load 2.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 143.1 | 10.26 |
| 2 | 60.1 | 5.61 |
| 3 | 30.1 | 3.31 |
| 4 | 120.3 | 3.10 |
| 5 | 285.0 | 2.06 |
| 6 | 105.8 | 0.91 |
| 7 | 113.0 | 0.88 |
| 8 | 135.9 | 0.80 |
| 9 | 240.5 | 0.64 |
| 10 | 90.2 | 0.61 |

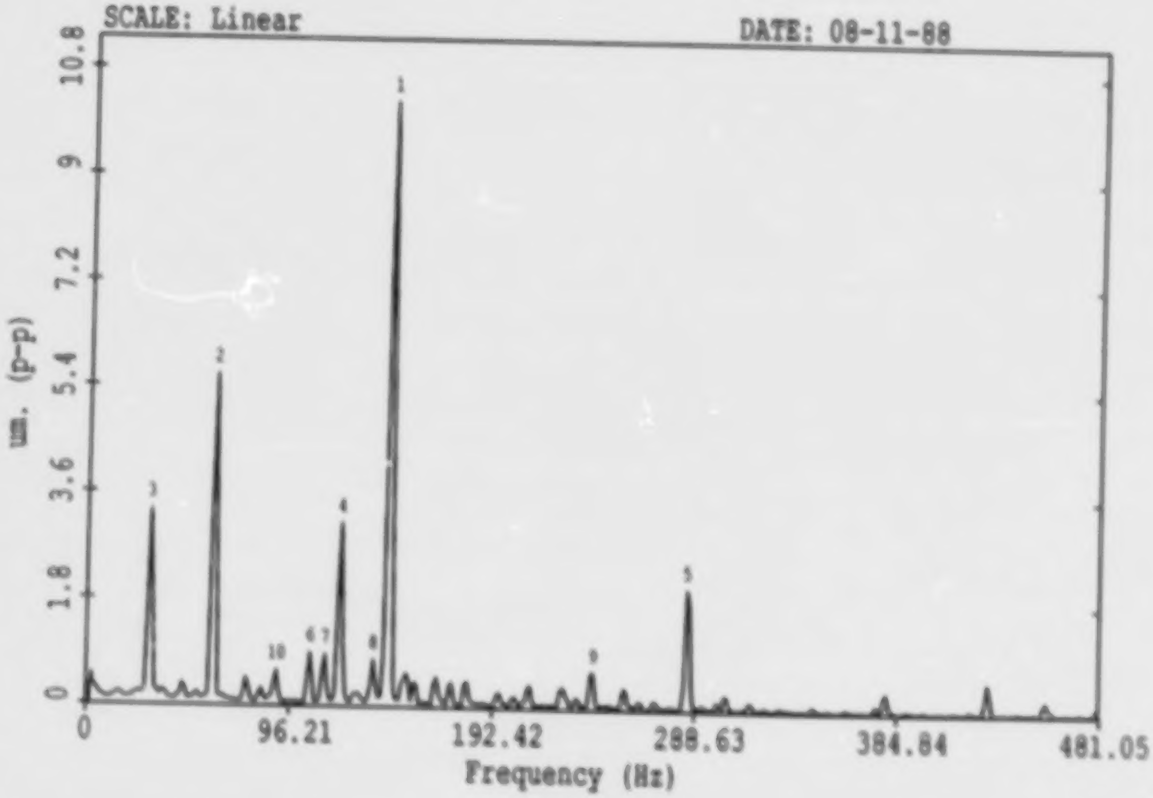

SCALE: Linear
DATE: 08-11-88

FIGURE D51

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #5 Shaft Displacement Horiz.
PROCESS CONDITION : Load 3.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 143.1 | 8.97 |
| 2 | 60.1 | 4.93 |
| 3 | 30.1 | 2.65 |
| 4 | 285.0 | 1.64 |
| 5 | 120.3 | 1.57 |
| 6 | 2.4 | 0.95 |
| 7 | 151.5 | 0.75 |
| 8 | 75.8 | 0.68 |
| 9 | 158.7 | 0.66 |
| 10 | 90.2 | 0.58 |

SCALE: Linear

DATE: 08-11-88

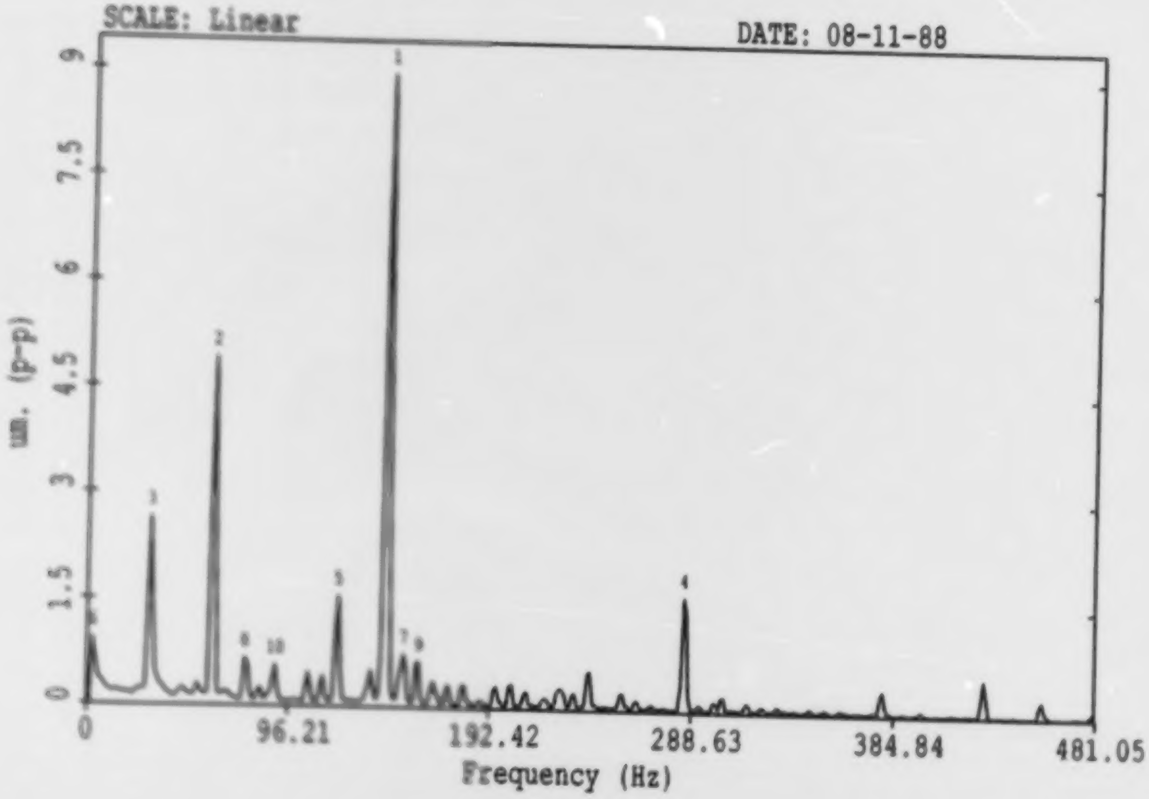


FIGURE D52

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #5 Shaft Displacement Horiz.
PROCESS CONDITION : Load 4.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 143.1 | 8.24 |
| 2 | 60.1 | 3.81 |
| 3 | 30.1 | 1.92 |
| 4 | 120.3 | 1.38 |
| 5 | 285.0 | 1.16 |
| 6 | 160.0 | 0.76 |
| 7 | 75.8 | 0.74 |
| 8 | 151.5 | 0.67 |
| 9 | 89.0 | 0.58 |
| 10 | 428.1 | 0.50 |

SCALE: Linear

DATE: 08-11-88

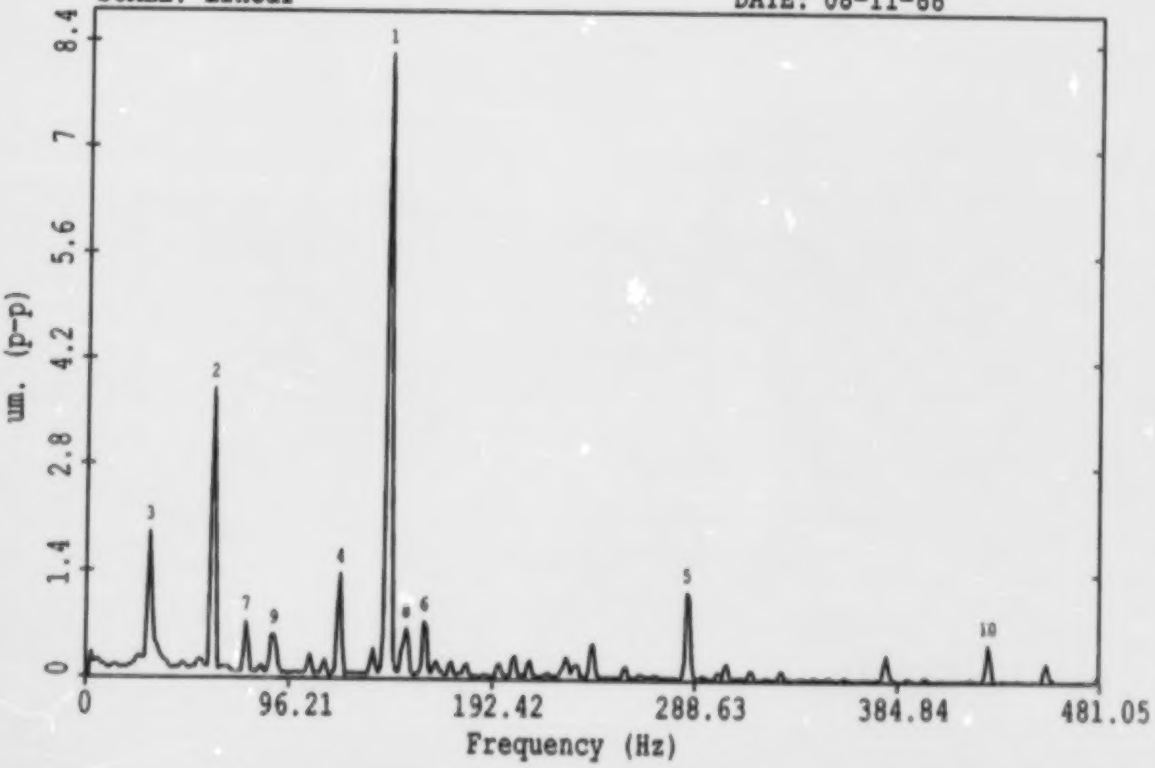


FIGURE D53

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #5 Shaft Displacement Horiz.
PROCESS CONDITION : Load 5.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 143.1 | 7.43 |
| 2 | 60.1 | 3.35 |
| 3 | 30.1 | 1.90 |
| 4 | 120.3 | 1.35 |
| 5 | 75.8 | 0.88 |
| 6 | 162.4 | 0.78 |
| 7 | 285.0 | 0.57 |
| 8 | 98.6 | 0.53 |
| 9 | 151.5 | 0.53 |
| 10 | 428.1 | 0.49 |

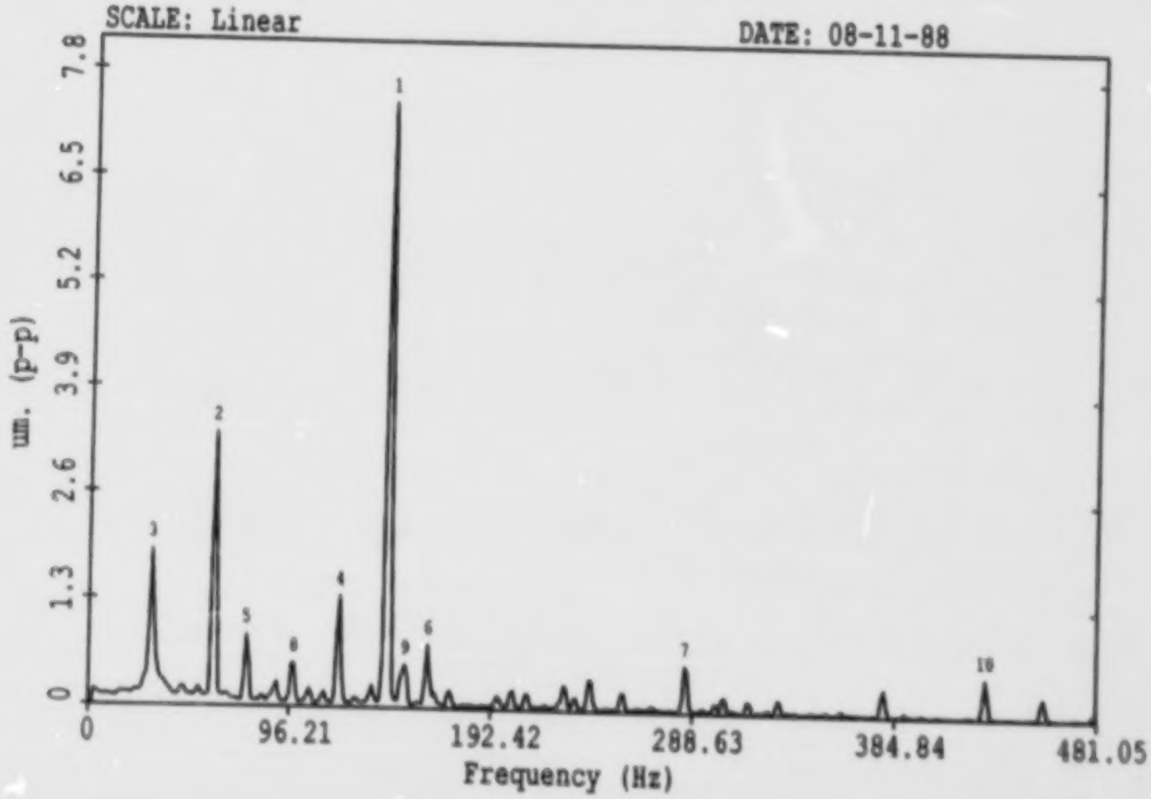


FIGURE D54

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #5 Shaft Displacement Horiz.
PROCESS CONDITION : Load 6.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 143.1 | 7.39 |
| 2 | 60.1 | 3.41 |
| 3 | 30.1 | 1.58 |
| 4 | 120.3 | 1.26 |
| 5 | 75.8 | 1.05 |
| 6 | 150.3 | 0.52 |
| 7 | 167.2 | 0.51 |
| 8 | 428.1 | 0.49 |
| 9 | 240.5 | 0.41 |
| 10 | 380.0 | 0.34 |

SCALE: Linear

DATE: 08-11-88

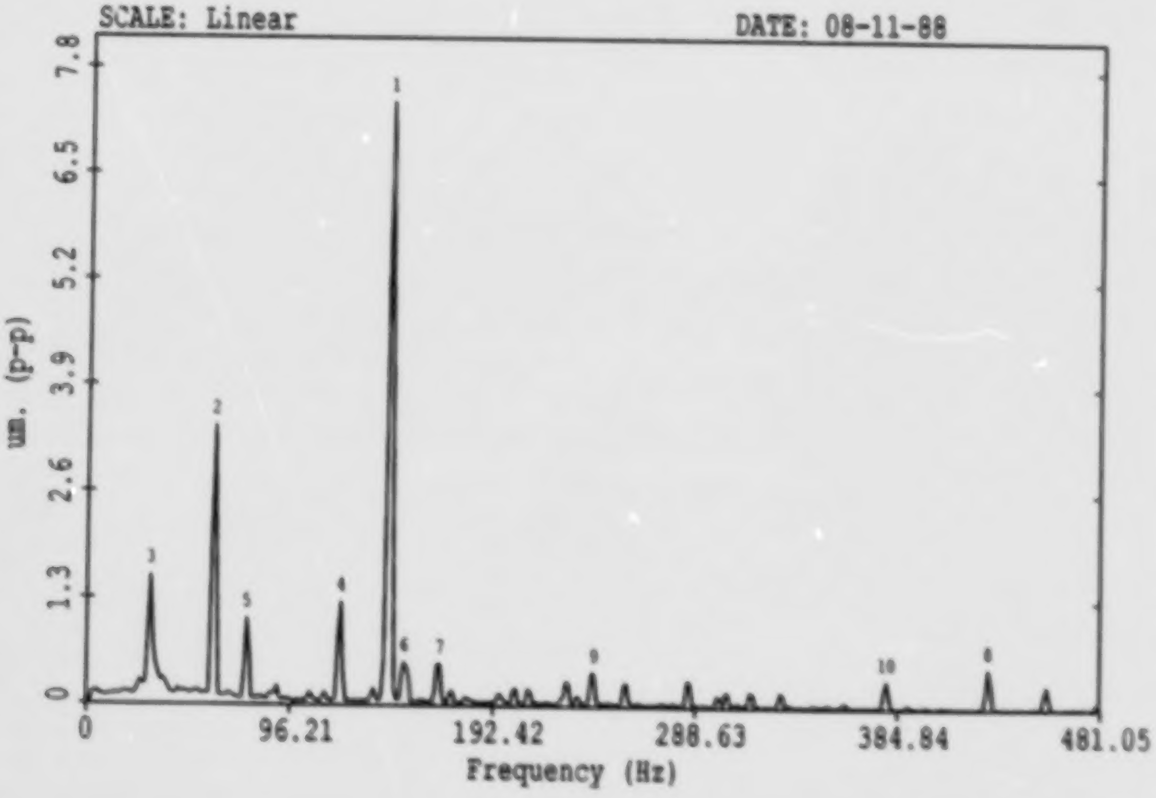
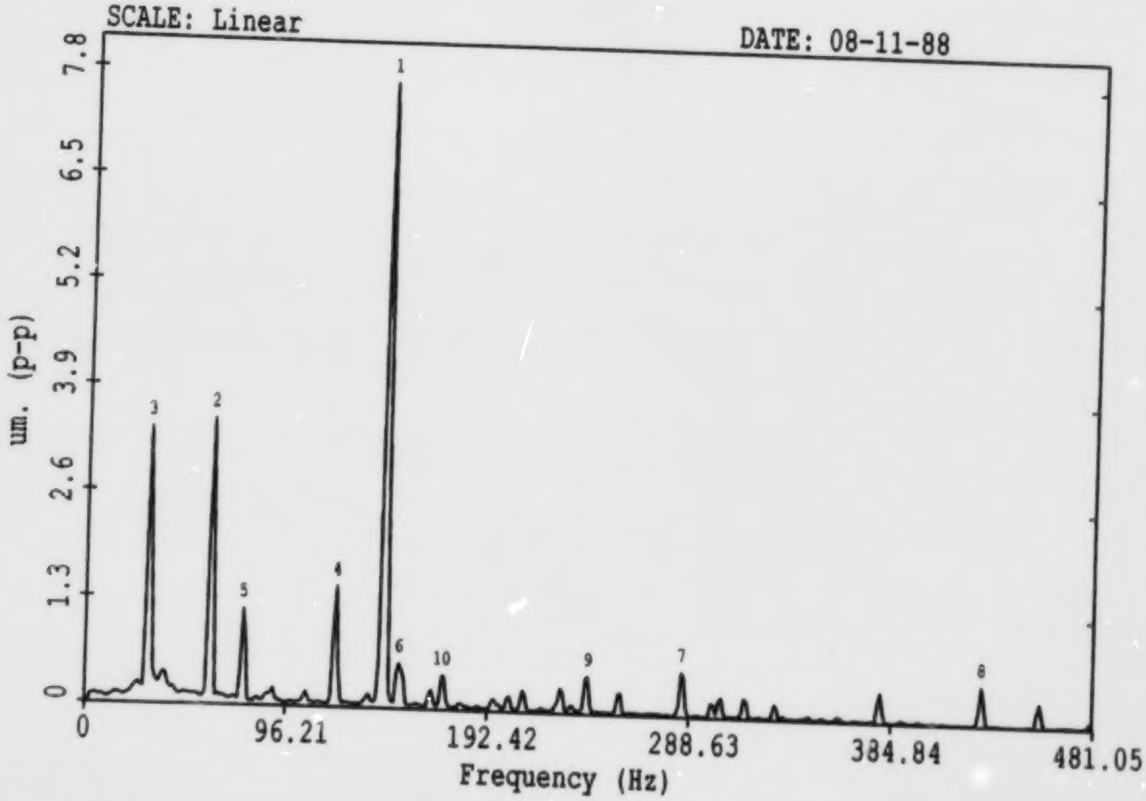


FIGURE D55

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #5 Shaft Displacement Horiz.
PROCESS CONDITION : Load 6.9 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 143.1 | 7.68 |
| 2 | 60.1 | 3.51 |
| 3 | 30.1 | 3.38 |
| 4 | 120.3 | 1.48 |
| 5 | 75.8 | 1.18 |
| 6 | 150.3 | 0.55 |
| 7 | 285.0 | 0.54 |
| 8 | 428.1 | 0.48 |
| 9 | 240.5 | 0.46 |
| 10 | 170.8 | 0.42 |



SCALE: Linear

DATE: 08-11-88

FIGURE D56

# APPENDIX E

# ACCESSORY GEARBOX VELOCITY SPECTRA

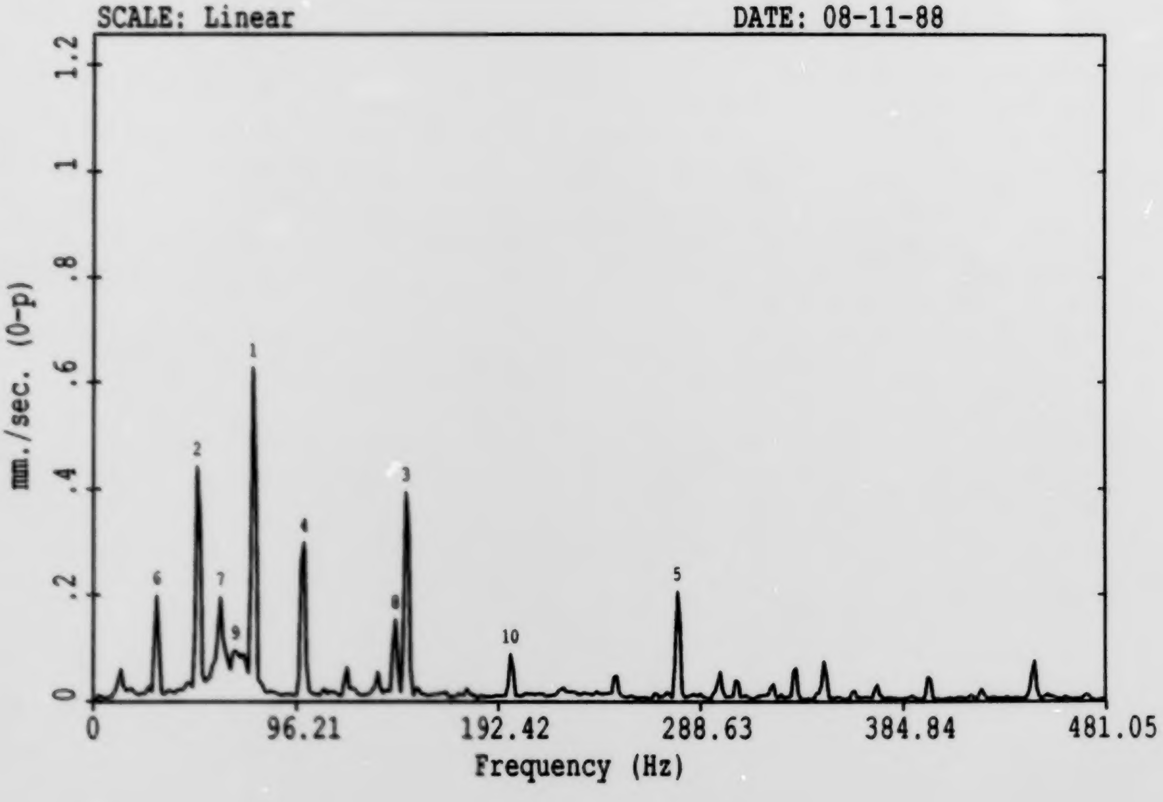
## TABLE E1
## DARLINGTON NGS 'A' EMERGENCY POWER GENERATOR #1 - ACCESSORY GEARBOX
## FIGURE NUMBERS OF VELOCITY SPECTRA

| Measurement | | FFT Spectrum<br>Figure No.<br>Load (MW) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 6.9 |
| Accessory Gearbox Casing Velocity | Horizontal Direction | E1 | E2 | E3 | E4 | E5 | E6 | E7 | E8 |

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Accessory Gearbox Casing Velocity Horiz.
PROCESS CONDITION : Load 0.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 75.8 | 0.63 |
| 2 | 49.3 | 0.44 |
| 3 | 147.9 | 0.40 |
| 4 | 99.8 | 0.30 |
| 5 | 277.8 | 0.21 |
| 6 | 30.1 | 0.20 |
| 7 | 60.1 | 0.20 |
| 8 | 143.1 | 0.15 |
| 9 | 67.3 | 0.10 |
| 10 | 198.4 | 0.09 |


SCALE: Linear

DATE: 08-11-88

**FIGURE E1**

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Accessory Gearbox Casing Velocity Horiz.
PROCESS CONDITION : Load 1.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 50.5 | 0.67 |
| 2 | 75.8 | 0.52 |
| 3 | 151.5 | 0.39 |
| 4 | 102.2 | 0.30 |
| 5 | 60.1 | 0.29 |
| 6 | 30.1 | 0.18 |
| 7 | 55.3 | 0.17 |
| 8 | 285.0 | 0.16 |
| 9 | 203.2 | 0.13 |
| 10 | 80.6 | 0.13 |

SCALE: Linear DATE: 08-11-88

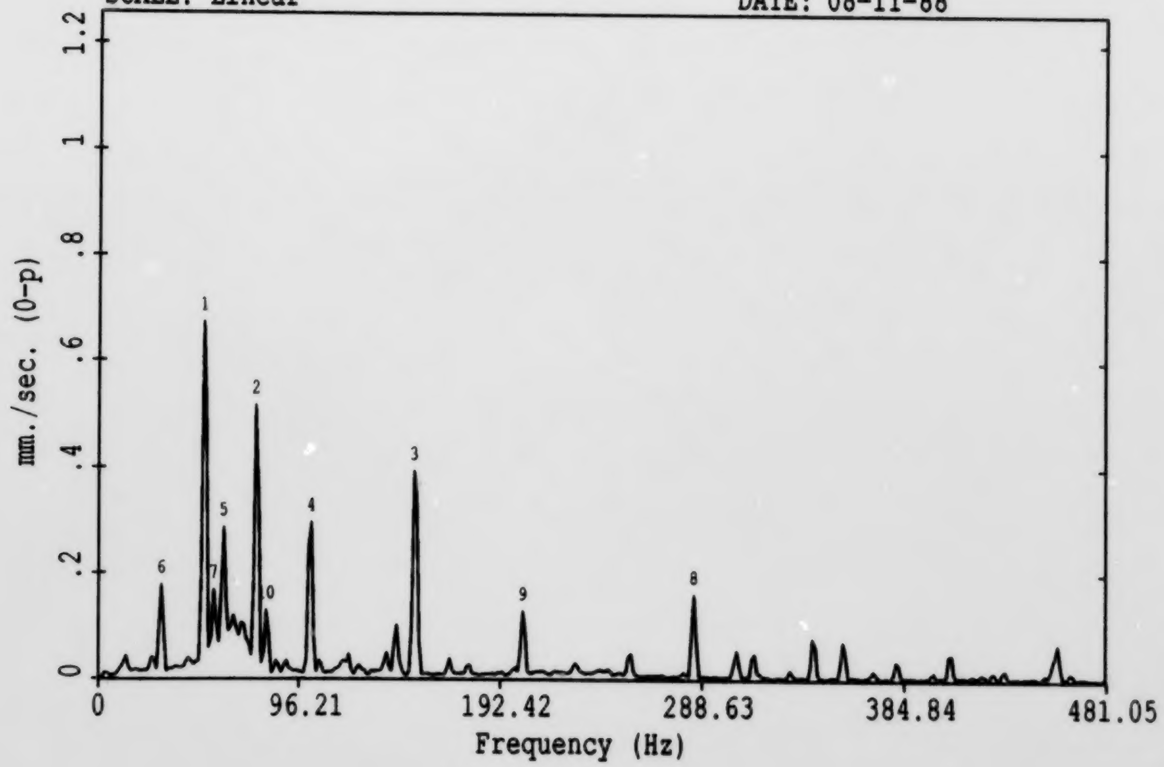


FIGURE E2

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Accessory Gearbox Casing Velocity Horiz.
PROCESS CONDITION : Load 2.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 75.8 | 0.62 |
| 2 | 60.1 | 0.59 |
| 3 | 51.7 | 0.56 |
| 4 | 156.3 | 0.39 |
| 5 | 104.6 | 0.28 |
| 6 | 30.1 | 0.21 |
| 7 | 208.1 | 0.21 |
| 8 | 143.1 | 0.18 |
| 9 | 292.2 | 0.10 |
| 10 | 90.2 | 0.07 |

SCALE: Linear DATE: 08-11-88

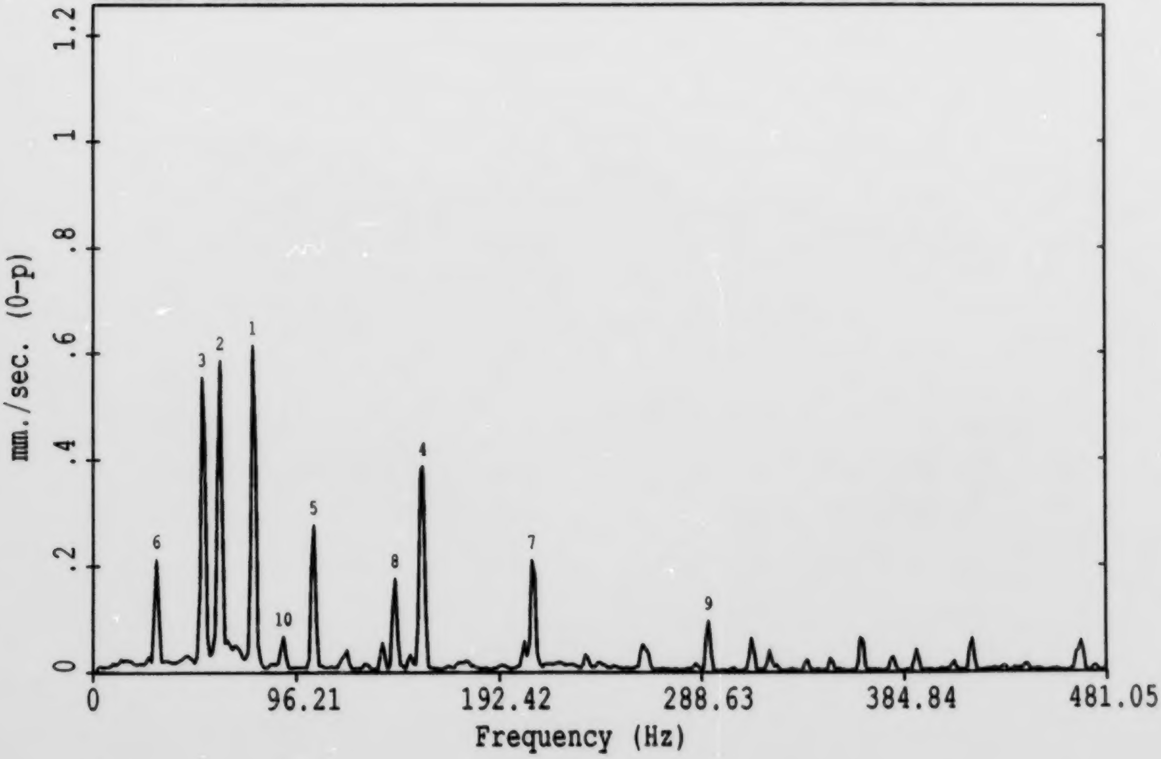


FIGURE E3

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Accessory Gearbox Casing Velocity Horiz.
PROCESS CONDITION : Load 3.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 52.9 | 0.76 |
| 2 | 75.8 | 0.63 |
| 3 | 60.1 | 0.56 |
| 4 | 158.7 | 0.42 |
| 5 | 211.7 | 0.26 |
| 6 | 105.8 | 0.23 |
| 7 | 143.1 | 0.17 |
| 8 | 30.1 | 0.16 |
| 9 | 356.0 | 0.16 |
| 10 | 297.1 | 0.12 |

SCALE: Linear DATE: 08-11-88

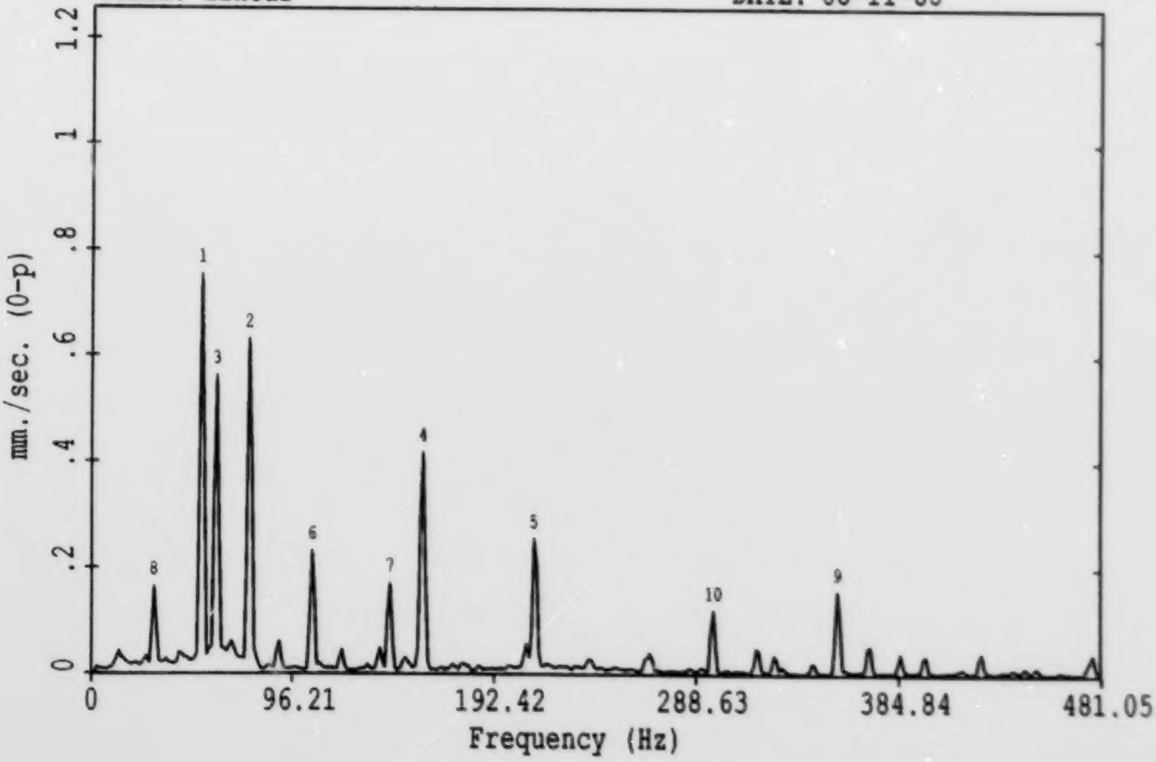


FIGURE E4

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Accessory Gearbox Casing Velocity Horiz.
PROCESS CONDITION : Load 4.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 75.8 | 0.62 |
| 2 | 54.1 | 0.55 |
| 3 | 161.2 | 0.44 |
| 4 | 60.1 | 0.41 |
| 5 | 215.3 | 0.32 |
| 6 | 300.7 | 0.31 |
| 7 | 107.0 | 0.22 |
| 8 | 143.1 | 0.15 |
| 9 | 30.1 | 0.15 |
| 10 | 67.3 | 0.07 |

SCALE: Linear DATE: 08-11-88

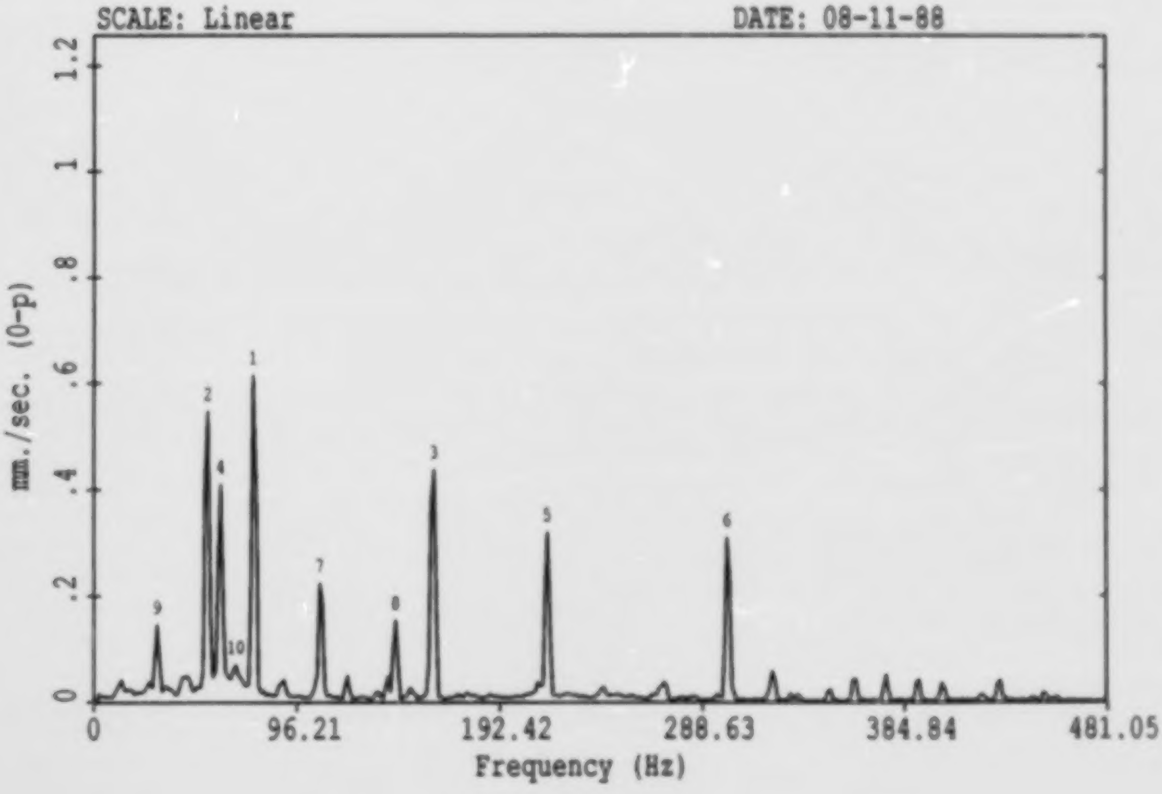


FIGURE E5

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Accessory Gearbox Casing Velocity Horiz.
PROCESS CONDITION : Load 5.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 75.8 | 0.69 |
| 2 | 162.4 | 0.50 |
| 3 | 217.7 | 0.37 |
| 4 | 304.3 | 0.33 |
| 5 | 60.1 | 0.30 |
| 6 | 54.1 | 0.30 |
| 7 | 108.2 | 0.23 |
| 8 | 30.1 | 0.17 |
| 9 | 143.1 | 0.15 |
| 10 | 67.3 | 0.06 |

SCALE: Linear

DATE: 08-11-88

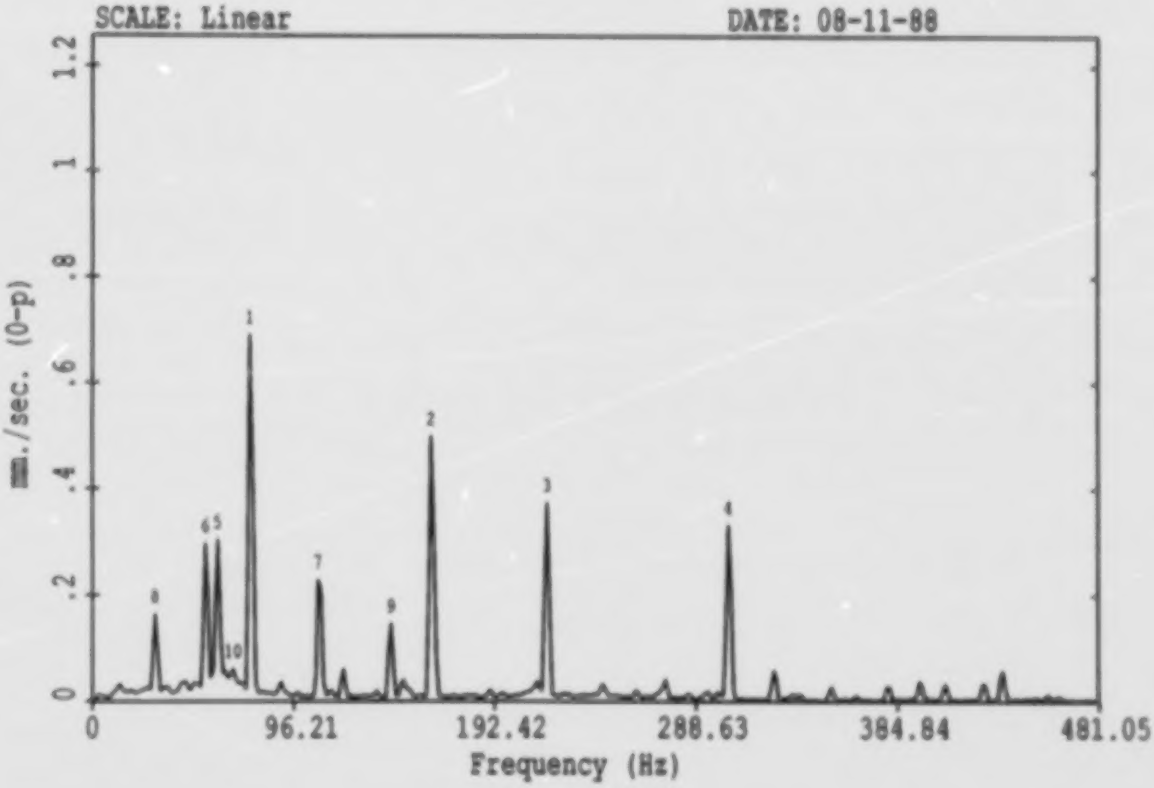


FIGURE E6

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Accessory Gearbox Casing Velocity Horiz.
PROCESS CONDITION : Load 6.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 75.8 | 0.74 |
| 2 | 55.3 | 0.65 |
| 3 | 167.2 | 0.50 |
| 4 | 312.7 | 0.29 |
| 5 | 111.8 | 0.28 |
| 6 | 223.7 | 0.25 |
| 7 | 60.1 | 0.22 |
| 8 | 30.1 | 0.17 |
| 9 | 143.1 | 0.16 |
| 10 | 446.2 | 0.08 |

SCALE: Linear

DATE: 08-11-88

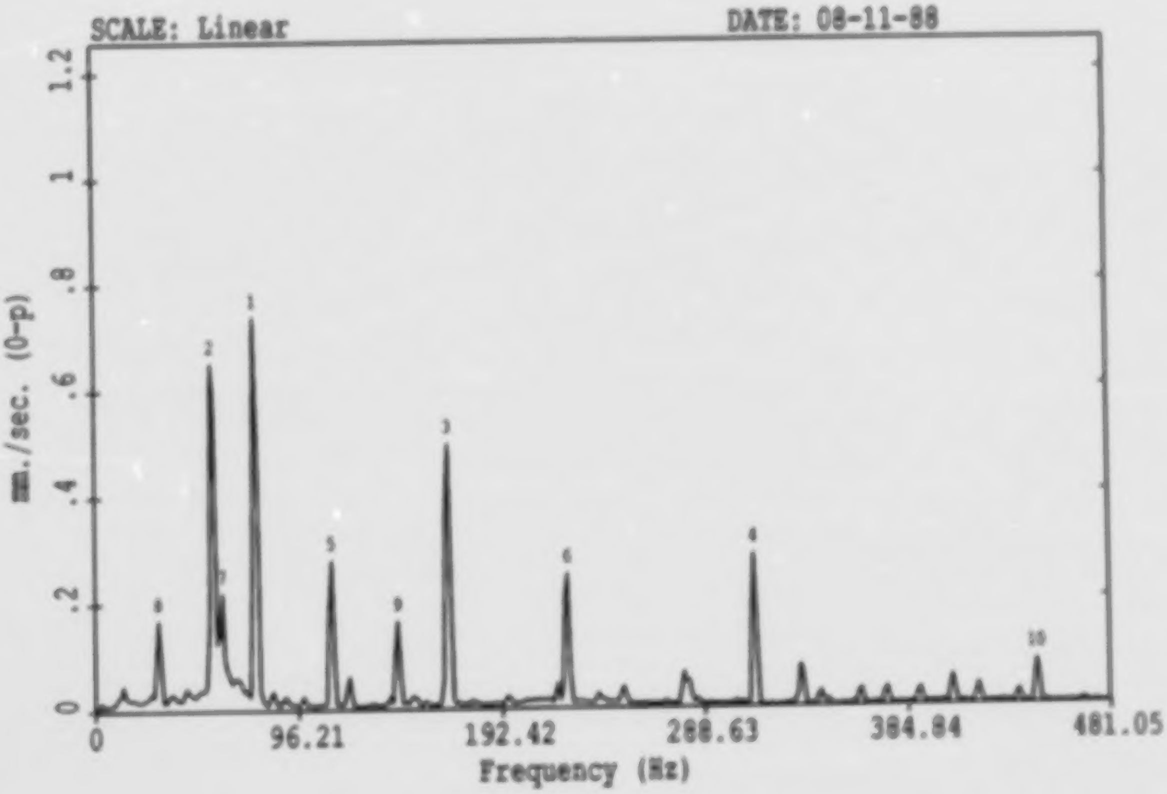
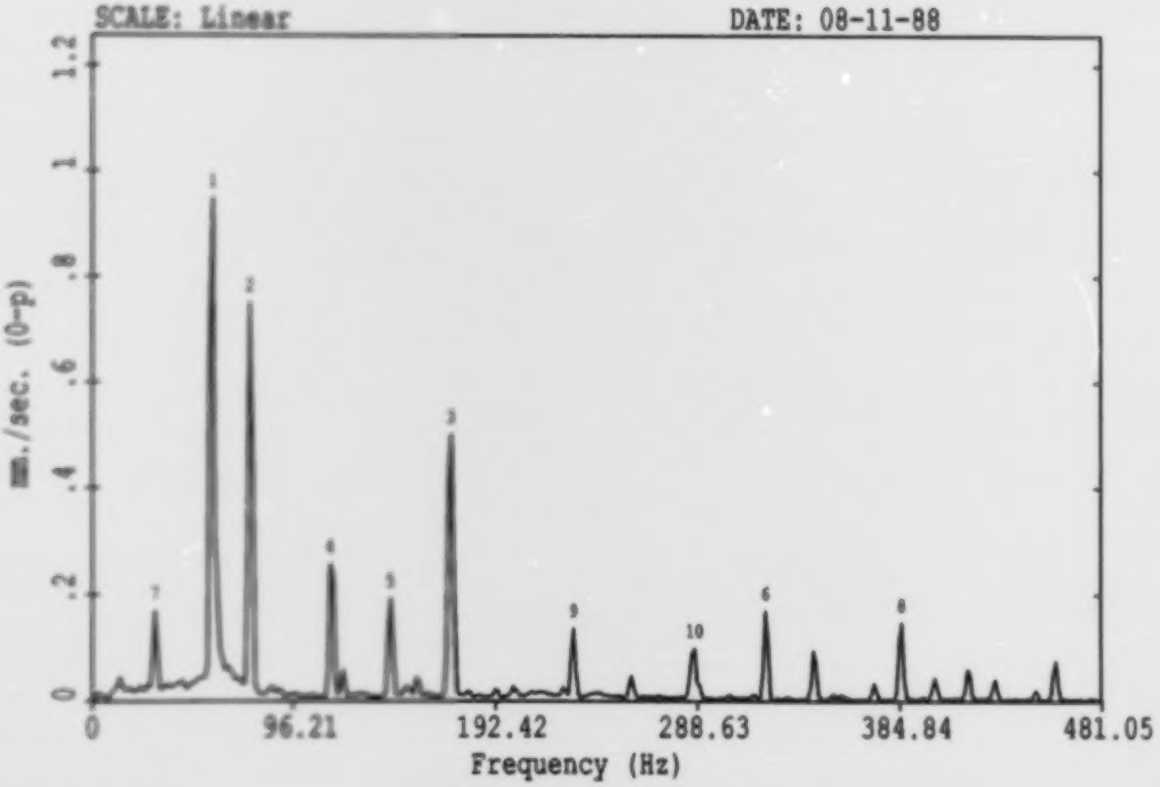


FIGURE E7

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Accessory Gearbox Casing Velocity Horiz.
PROCESS CONDITION : Load 6.9 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 57.7 | 0.95 |
| 2 | 75.8 | 0.75 |
| 3 | 172.0 | 0.50 |
| 4 | 114.3 | 0.26 |
| 5 | 143.1 | 0.19 |
| 6 | 321.1 | 0.17 |
| 7 | 30.1 | 0.17 |
| 8 | 386.0 | 0.15 |
| 9 | 229.7 | 0.14 |
| 10 | 287.4 | 0.10 |



SCALE: Linear

DATE: 08-11-88

FIGURE E8

# APPENDIX F

## GAS PRODUCER DISPLACEMENT SPECTRA

## TABLE F1
## DARLINGTON NGS 'A' EMERGENCY POWER GENERATOR #1 - GAS PRODUCER
## FIGURE NUMBERS OF DISPLACEMENT SPECTRA

| Measurement | | FFT Spectrum Figure No. | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Load (MW) | | | | | | | |
| | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 6.9 |
| Bearing No 1 Shaft Displacement | Vertical Direction | F1 | F2 | F3 | F4 | F5 | F6 | F7 | F8 |
| | Horizontal Direction | F9 | F10 | F11 | F12 | F13 | F14 | F15 | F16 |
| Bearing No 2 Shaft Displacement | Vertical Direction | F17 | F18 | F19 | F20 | F21 | F22 | F23 | F24 |
| | Horizontal Direction | F25 | F26 | F27 | F28 | F29 | F30 | F31 | F32 |
| Bearing No 3 Shaft Displacement | Vertical Direction | F33 | F34 | F35 | F36 | F37 | F38 | F39 | F40 |
| | Horizontal Direction | F41 | F42 | F43 | F44 | F45 | F46 | F47 | F48 |

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #1 Shaft Displacement Vert.
PROCESS CONDITION : Load 0.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 147.9 | 5.73 |
| 2 | 143.1 | 1.72 |
| 3 | 7.2 | 0.91 |
| 4 | 10.8 | 0.89 |
| 5 | 4.8 | 0.87 |
| 6 | 18.0 | 0.57 |
| 7 | 297.1 | 0.46 |
| 8 | 21.6 | 0.38 |
| 9 | 25.3 | 0.36 |
| 10 | 30.1 | 0.34 |

SCALE: Linear

DATE: 08-11-88

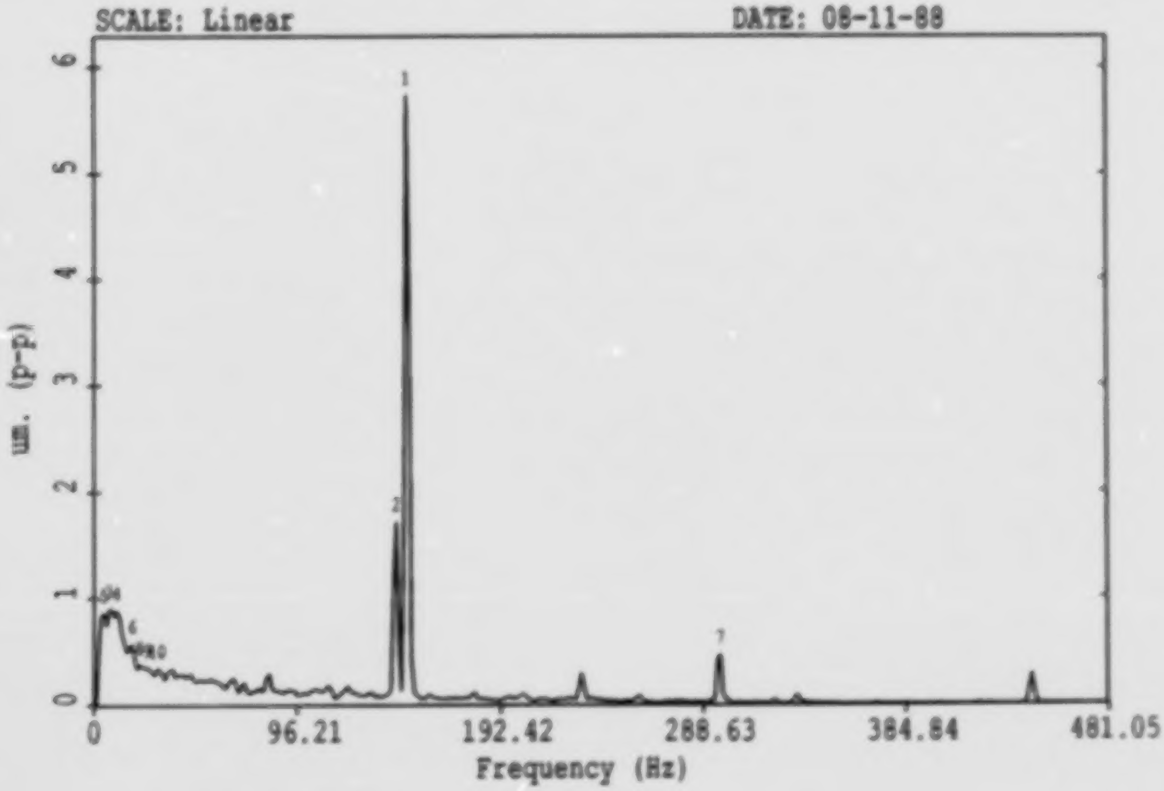


FIGURE F1

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #1 Shaft Displacement Vert.
PROCESS CONDITION : Load 1.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 151.5 | 6.79 |
| 2 | 143.1 | 1.52 |
| 3 | 2.4 | 1.17 |
| 4 | 8.4 | 0.95 |
| 5 | 18.0 | 0.56 |
| 6 | 13.2 | 0.53 |
| 7 | 244.1 | 0.48 |
| 8 | 91.4 | 0.43 |
| 9 | 304.3 | 0.42 |
| 10 | 28.9 | 0.40 |

SCALE: Linear

DATE: 08-11-88

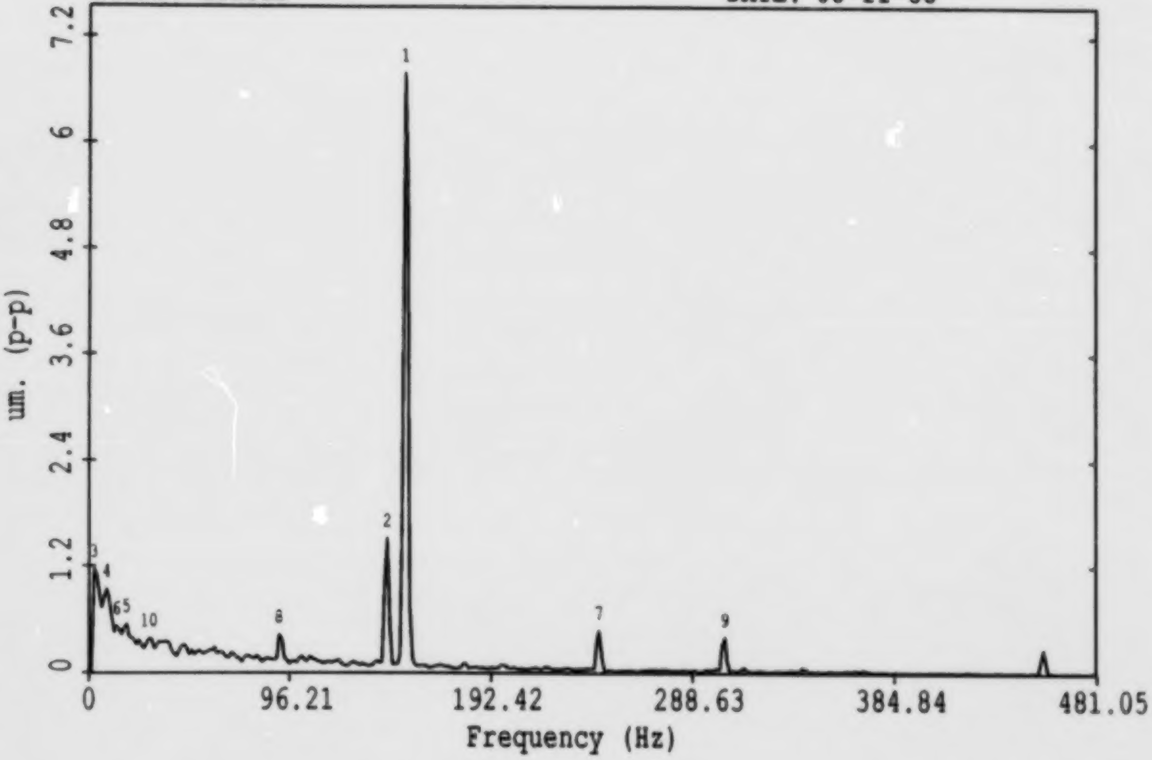


FIGURE F2

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #1 Shaft Displacement Vert.
PROCESS CONDITION : Load 2.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 155.1 | 5.52 |
| 2 | 143.1 | 1.24 |
| 3 | 4.8 | 1.09 |
| 4 | 8.4 | 0.63 |
| 5 | 14.4 | 0.58 |
| 6 | 311.5 | 0.51 |
| 7 | 60.1 | 0.42 |
| 8 | 20.4 | 0.40 |
| 9 | 22.9 | 0.40 |
| 10 | 26.5 | 0.35 |

SCALE: Linear

DATE: 08-11-88

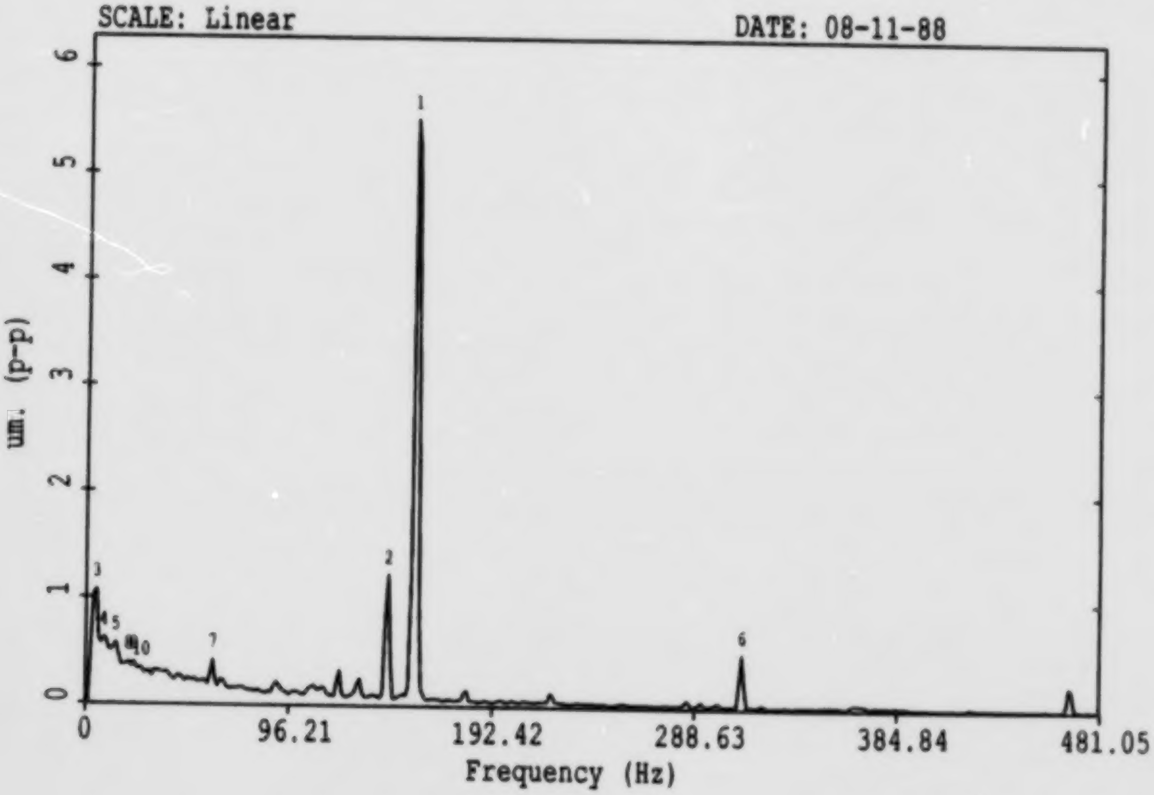


FIGURE F3

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #1 Shaft Displacement Vert.
PROCESS CONDITION : Load 3.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 158.7 | 5.63 |
| 2 | 143.1 | 1.09 |
| 3 | 3.6 | 0.92 |
| 4 | 8.4 | 0.57 |
| 5 | 13.2 | 0.54 |
| 6 | 316.3 | 0.50 |
| 7 | 18.0 | 0.46 |
| 8 | 30.1 | 0.46 |
| 9 | 33.7 | 0.41 |
| 10 | 77.0 | 0.34 |

SCALE: Linear

DATE: 08-11-88

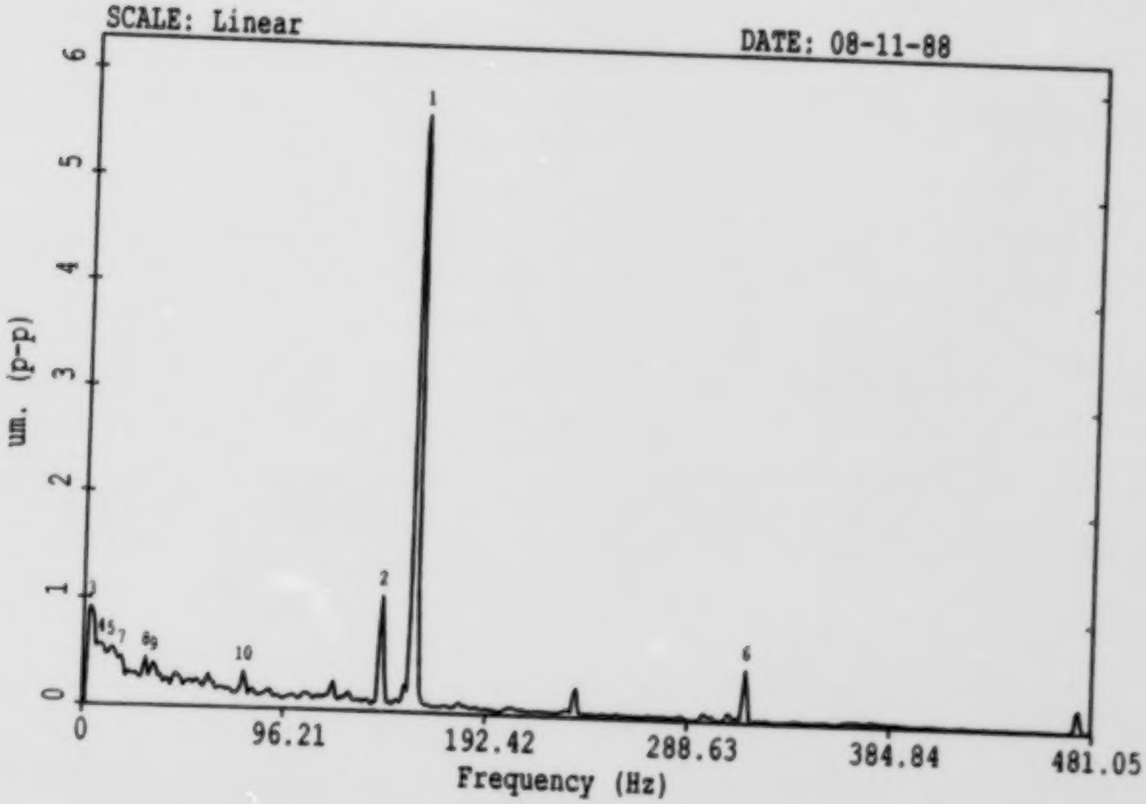


FIGURE F4

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #1 Shaft Displacement Vert.
PROCESS CONDITION : Load 4.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 160.0 | 6.46 |
| 2 | 143.1 | 1.11 |
| 3 | 4.8 | 0.93 |
| 4 | 87.8 | 0.63 |
| 5 | 8.4 | 0.61 |
| 6 | 16.8 | 0.53 |
| 7 | 248.9 | 0.53 |
| 8 | 10.8 | 0.52 |
| 9 | 321.1 | 0.42 |
| 10 | 25.3 | 0.40 |

SCALE: Linear

DATE: 08-11-88

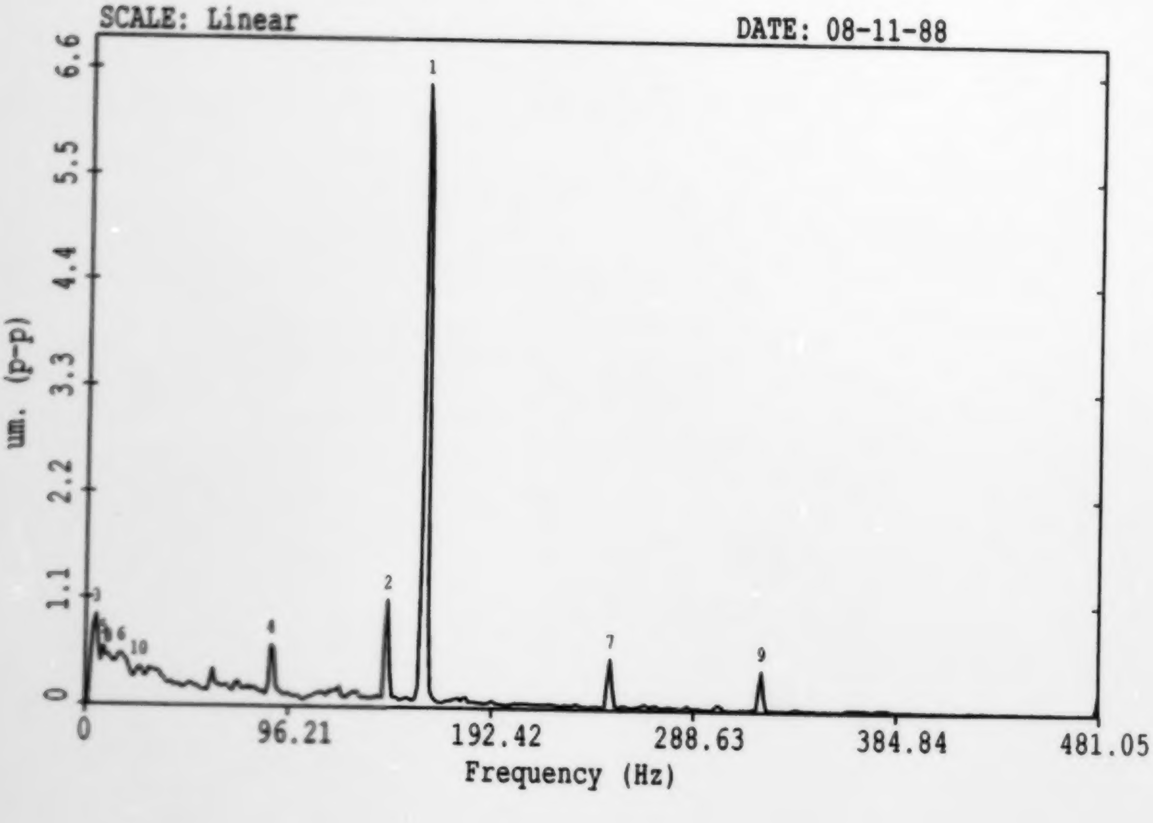


FIGURE F5

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #1 Shaft Displacement Vert.
PROCESS CONDITION : Load 5.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 162.4 | 8.22 |
| 2 | 143.1 | 1.12 |
| 3 | 98.6 | 1.10 |
| 4 | 3.6 | 0.87 |
| 5 | 261.0 | 0.68 |
| 6 | 14.4 | 0.55 |
| 7 | 16.8 | 0.52 |
| 8 | 324.7 | 0.46 |
| 9 | 9.6 | 0.43 |
| 10 | 22.9 | 0.43 |

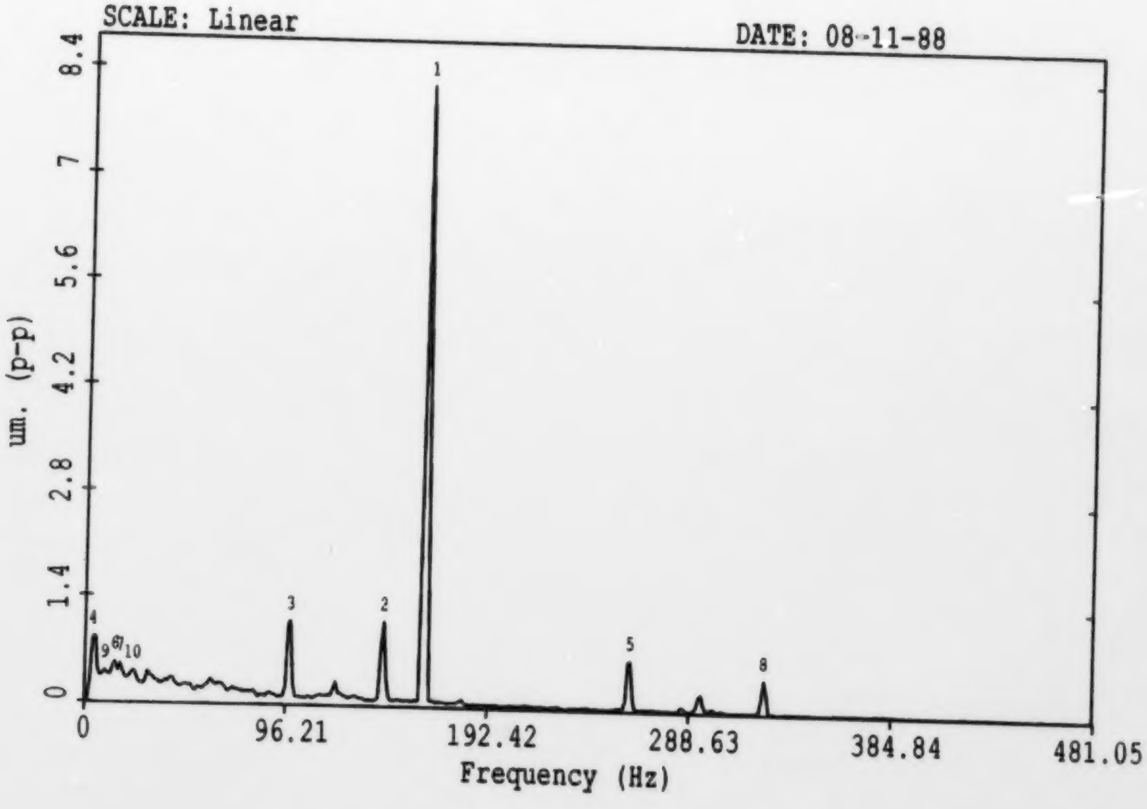


FIGURE F6

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #1 Shaft Displacement Vert.
PROCESS CONDITION : Load 6.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 167.2 | 5.49 |
| 2 | 143.1 | 1.15 |
| 3 | 4.8 | 0.92 |
| 4 | 333.1 | 0.53 |
| 5 | 30.1 | 0.52 |
| 6 | 16.8 | 0.51 |
| 7 | 13.2 | 0.44 |
| 8 | 34.9 | 0.39 |
| 9 | 21.6 | 0.37 |
| 10 | 119.1 | 0.35 |

SCALE: Linear

DATE: 08-11-88

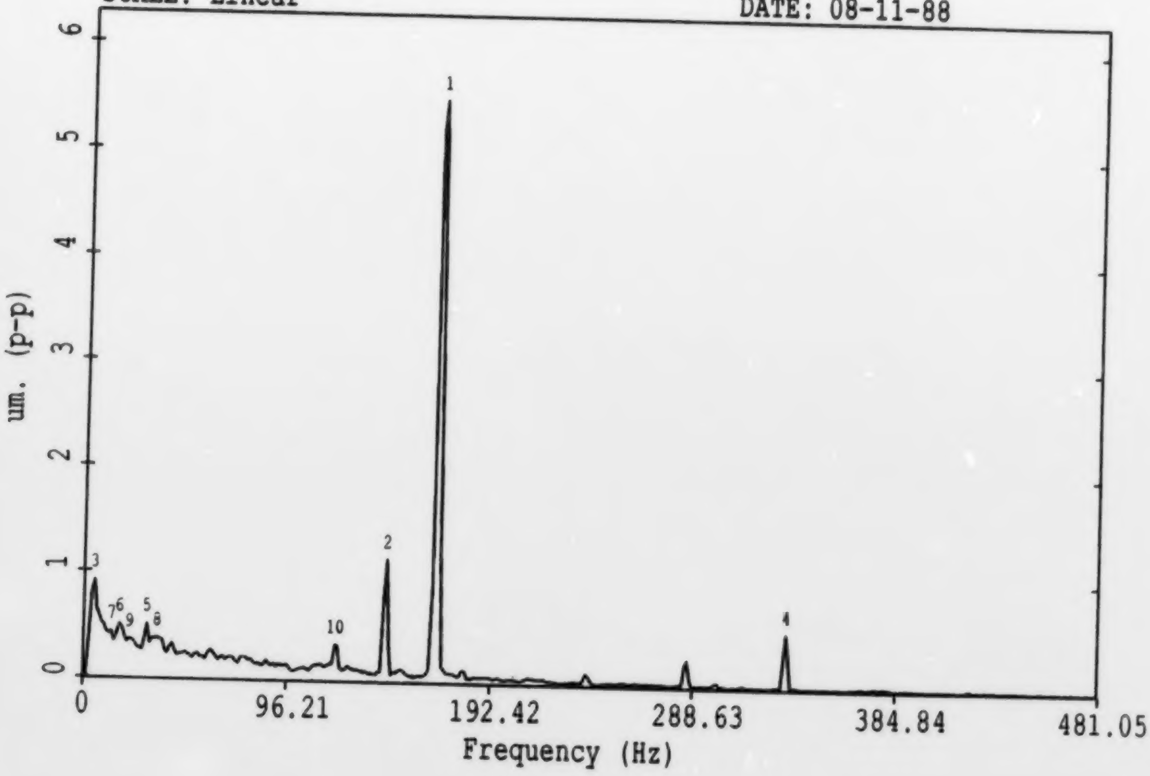


FIGURE F7

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #1 Shaft Displacement Vert.
PROCESS CONDITION : Load 6.9 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 170.8 | 5.91 |
| 2 | 143.1 | 1.17 |
| 3 | 4.8 | 0.80 |
| 4 | 9.6 | 0.51 |
| 5 | 16.8 | 0.47 |
| 6 | 14.4 | 0.45 |
| 7 | 30.1 | 0.43 |
| 8 | 342.8 | 0.39 |
| 9 | 25.3 | 0.39 |
| 10 | 20.4 | 0.36 |

SCALE: Linear

DATE: 08-11-88

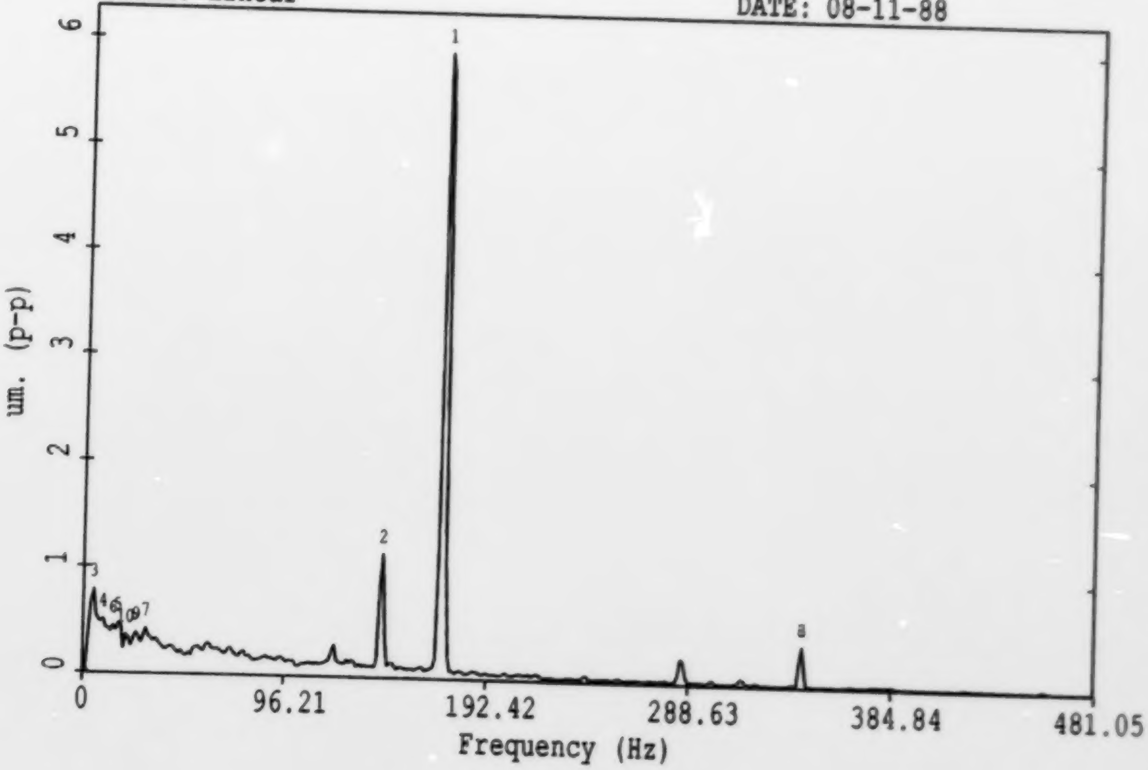


FIGURE F8

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #1 Shaft Displacement Horiz.
PROCESS CONDITION : Load 0.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 147.9 | 5.16 |
| 2 | 143.1 | 1.59 |
| 3 | 180.4 | 0.56 |
| 4 | 299.5 | 0.50 |
| 5 | 3.6 | 0.47 |
| 6 | 60.1 | 0.47 |
| 7 | 22.9 | 0.32 |
| 8 | 297.1 | 0.32 |
| 9 | 83.0 | 0.31 |
| 10 | 7.2 | 0.30 |

SCALE: Linear DATE: 08-11-88

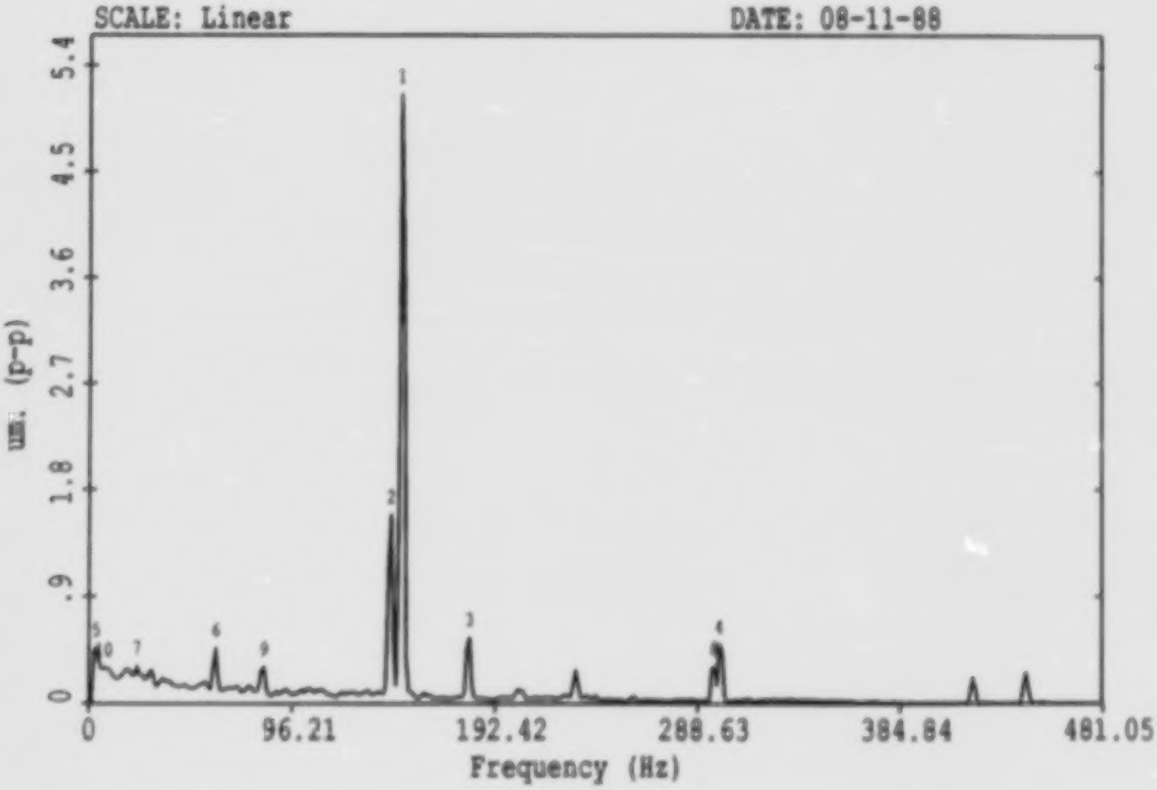


FIGURE F9

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #1 Shaft Displacement Horiz.
PROCESS CONDITION : Load 1.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 151.5 | 5.89 |
| 2 | 143.1 | 1.46 |
| 3 | 2.4 | 1.10 |
| 4 | 91.4 | 0.62 |
| 5 | 180.4 | 0.56 |
| 6 | 299.5 | 0.48 |
| 7 | 244.1 | 0.47 |
| 8 | 60.1 | 0.46 |
| 9 | 8.4 | 0.44 |
| 10 | 304.3 | 0.43 |

SCALE: Linear

DATE: 08-11-88

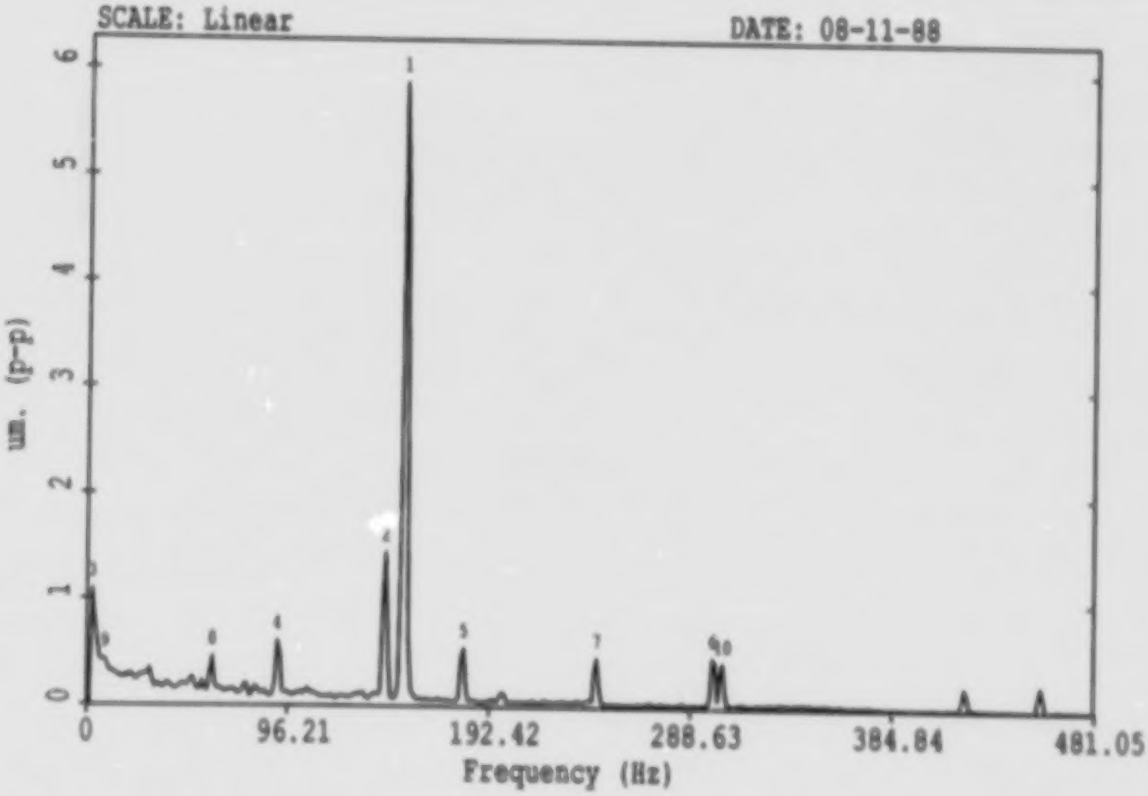


FIGURE F10

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #1 Shaft Displacement Horiz.
PROCESS CONDITION : Load 2.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 155.1 | 4.50 |
| 2 | 143.1 | 1.29 |
| 3 | 30.1 | 0.59 |
| 4 | 180.4 | 0.52 |
| 5 | 299.5 | 0.49 |
| 6 | 2.4 | 0.46 |
| 7 | 60.1 | 0.42 |
| 8 | 4.8 | 0.40 |
| 9 | 25.3 | 0.37 |
| 10 | 18.0 | 0.29 |

SCALE: Linear

DATE: 08-11-88

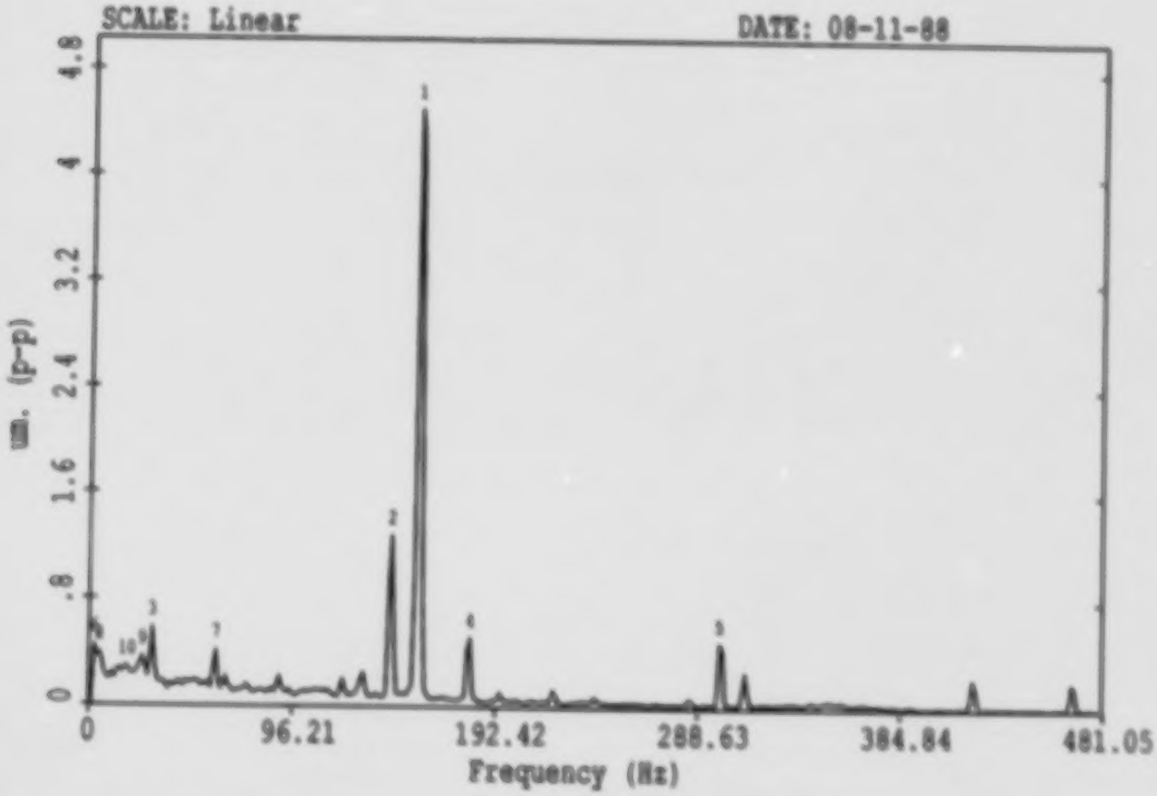


FIGURE F11

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #1 Shaft Displacement Horiz.
PROCESS CONDITION : Load 3.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 158.7 | 3.63 |
| 2 | 143.1 | 1.08 |
| 3 | 2.4 | 0.82 |
| 4 | 30.1 | 0.54 |
| 5 | 180.4 | 0.49 |
| 6 | 299.5 | 0.48 |
| 7 | 316.3 | 0.44 |
| 8 | 60.1 | 0.40 |
| 9 | 77.0 | 0.39 |
| 10 | 12.0 | 0.32 |

SCALE: Linear

DATE: 08-11-88

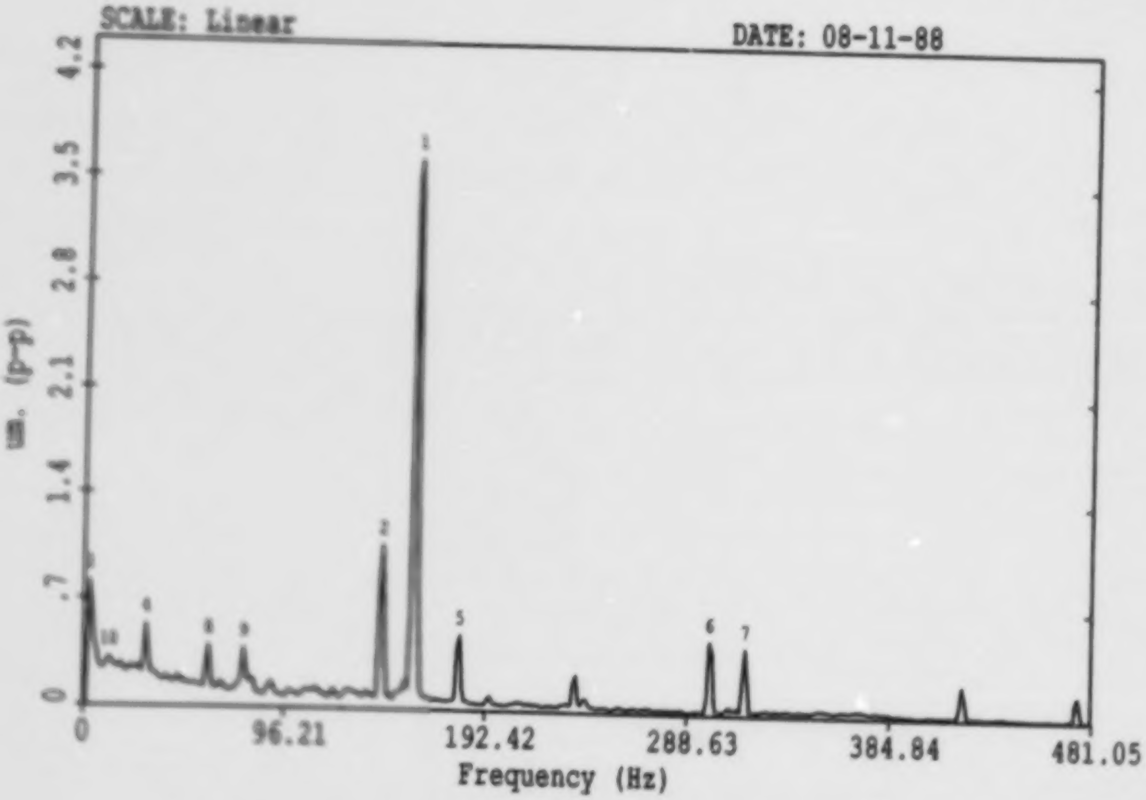


FIGURE F12

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #1 Shaft Displacement Horiz.
PROCESS CONDITION : Load 4.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 160.0 | 4.08 |
| 2 | 143.1 | 0.91 |
| 3 | 87.8 | 0.89 |
| 4 | 180.4 | 0.54 |
| 5 | 30.1 | 0.52 |
| 6 | 321.1 | 0.52 |
| 7 | 299.5 | 0.50 |
| 8 | 248.9 | 0.46 |
| 9 | 60.1 | 0.41 |
| 10 | 2.4 | 0.40 |

SCALE: Linear

DATE: 08-11-88

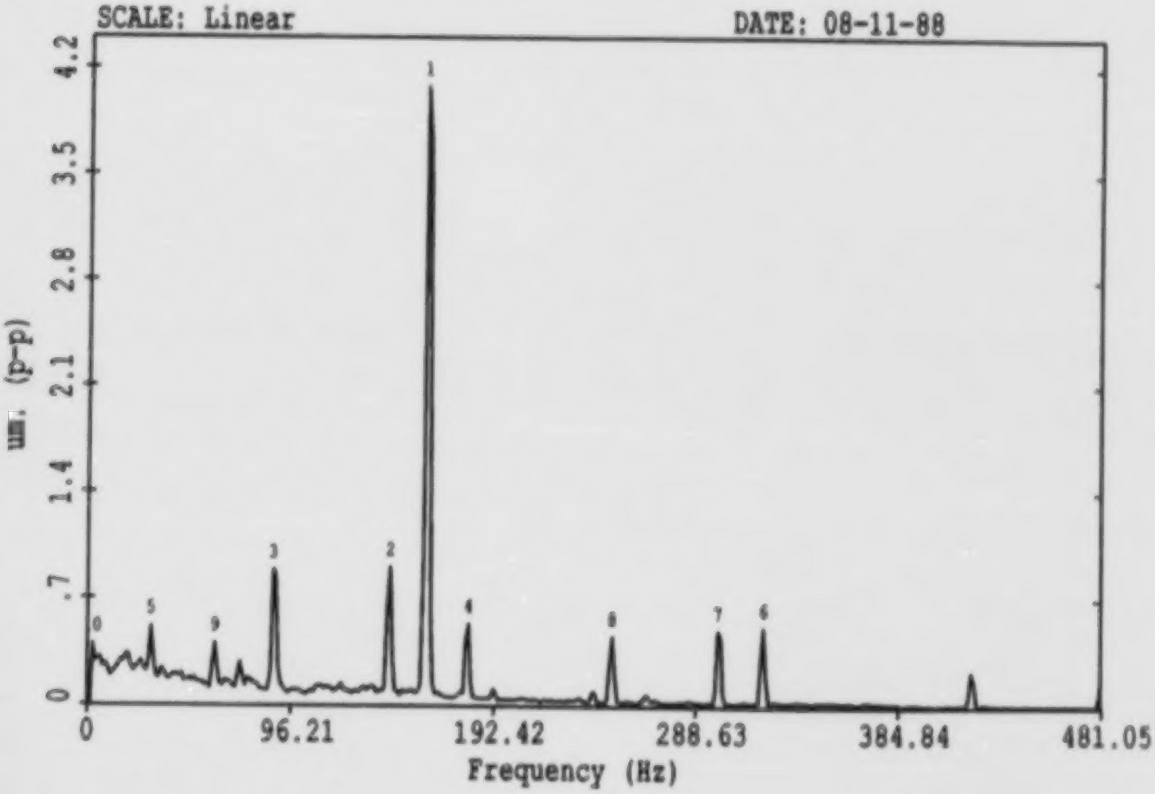


FIGURE F13

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #1 Shaft Displacement Horiz.
PROCESS CONDITION : Load 5.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 162.4 | 5.49 |
| 2 | 98.6 | 1.37 |
| 3 | 143.1 | 0.92 |
| 4 | 261.0 | 0.62 |
| 5 | 30.1 | 0.53 |
| 6 | 180.4 | 0.53 |
| 7 | 299.5 | 0.49 |
| 8 | 324.7 | 0.44 |
| 9 | 25.3 | 0.34 |
| 10 | 2.4 | 0.32 |

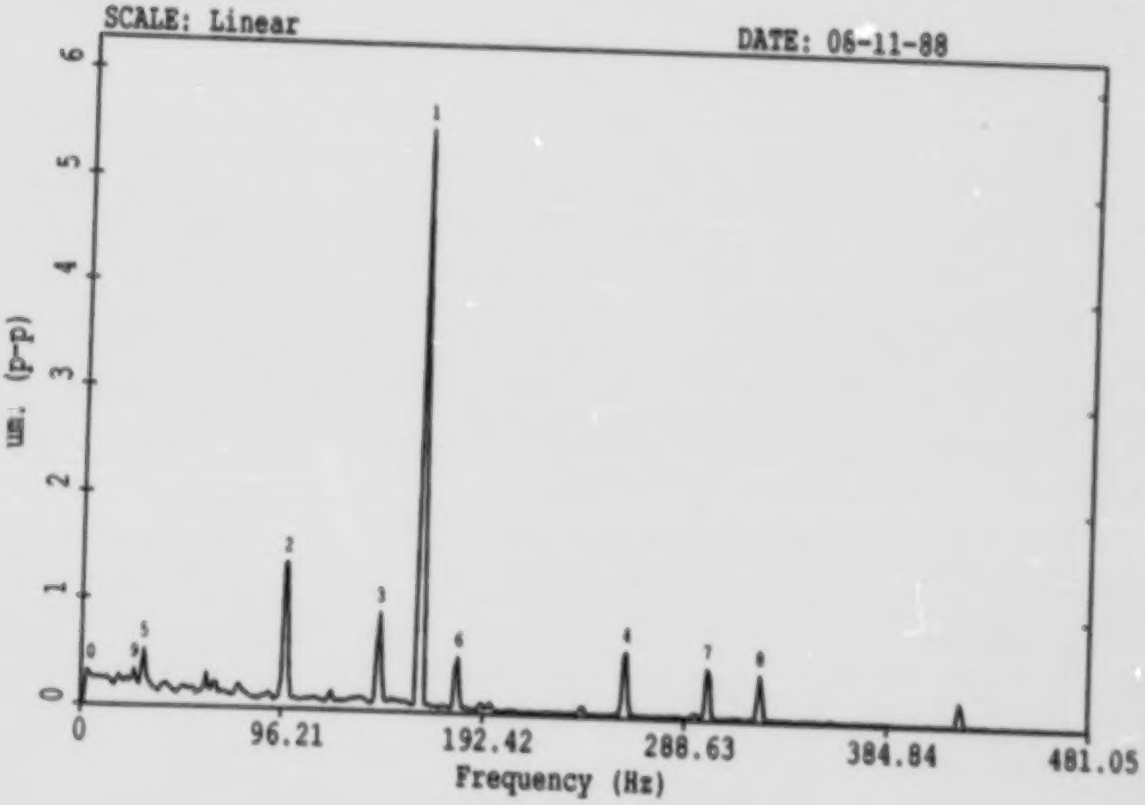


FIGURE F14

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #1 Shaft Displacement Horiz.
PROCESS CONDITION : Load 6.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 167.2 | 3.97 |
| 2 | 143.1 | 0.94 |
| 3 | 333.1 | 0.62 |
| 4 | 30.1 | 0.52 |
| 5 | 119.1 | 0.52 |
| 6 | 180.4 | 0.51 |
| 7 | 299.5 | 0.48 |
| 8 | 2.4 | 0.31 |
| 9 | 16.8 | 0.29 |
| 10 | 4.8 | 0.29 |

SCALE: Linear

DATE: 08-11-88

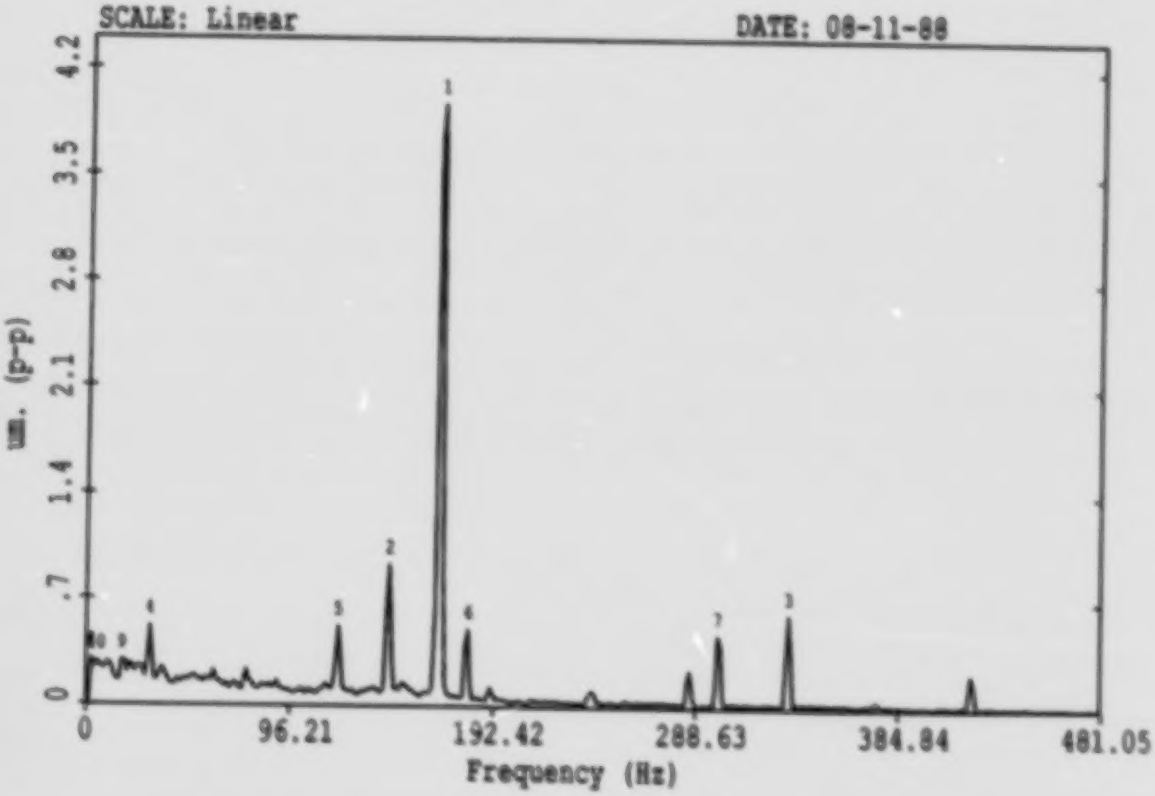


FIGURE F15

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #1 Shaft Displacement Horiz.
PROCESS CONDITION : Load 6.9 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 170.8 | 4.75 |
| 2 | 143.1 | 0.81 |
| 3 | 342.8 | 0.60 |
| 4 | 30.1 | 0.58 |
| 5 | 299.5 | 0.49 |
| 6 | 180.4 | 0.41 |
| 7 | 25.3 | 0.34 |
| 8 | 2.4 | 0.33 |
| 9 | 4.8 | 0.33 |
| 10 | 14.4 | 0.31 |

SCALE: Linear

DATE: 08-11-88

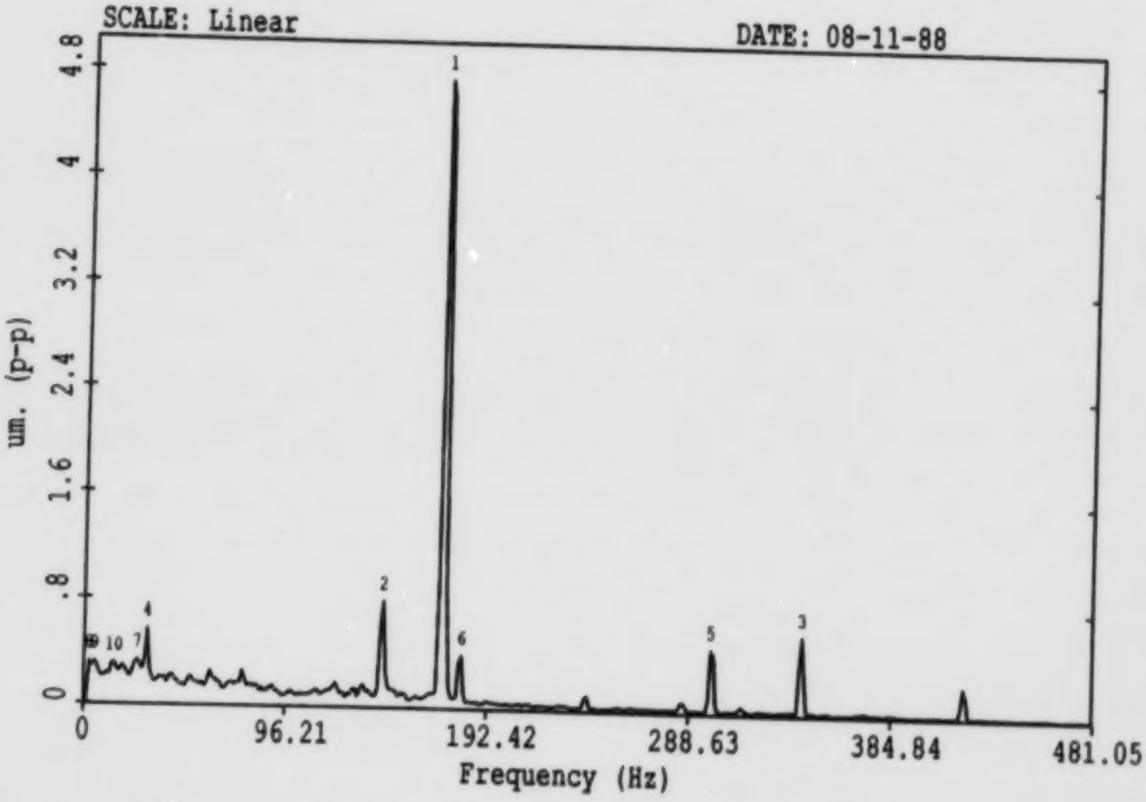


FIGURE F16

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #2 Shaft Displacement Vert.
PROCESS CONDITION : Load 0.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 147.9 | 18.17 |
| 2 | 297.1 | 3.74 |
| 3 | 22.9 | 0.95 |
| 4 | 2.4 | 0.68 |
| 5 | 12.0 | 0.62 |
| 6 | 30.1 | 0.59 |
| 7 | 8.4 | 0.58 |
| 8 | 26.5 | 0.48 |

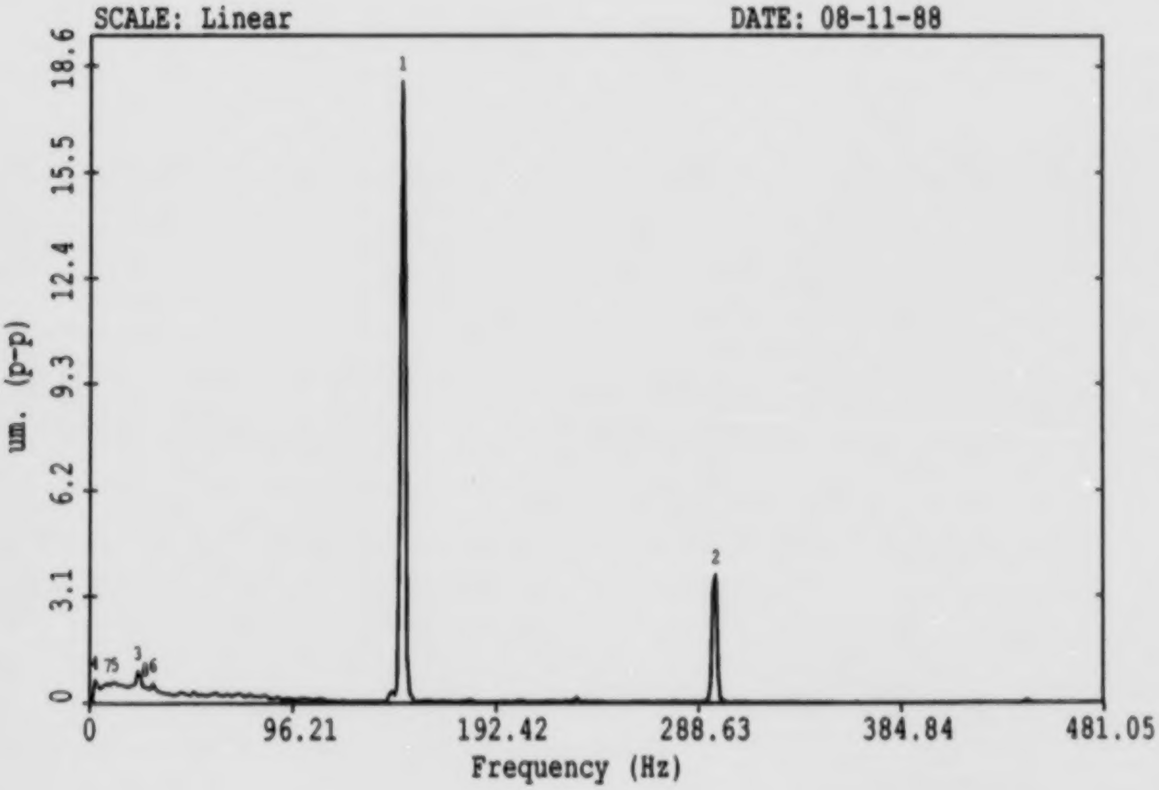
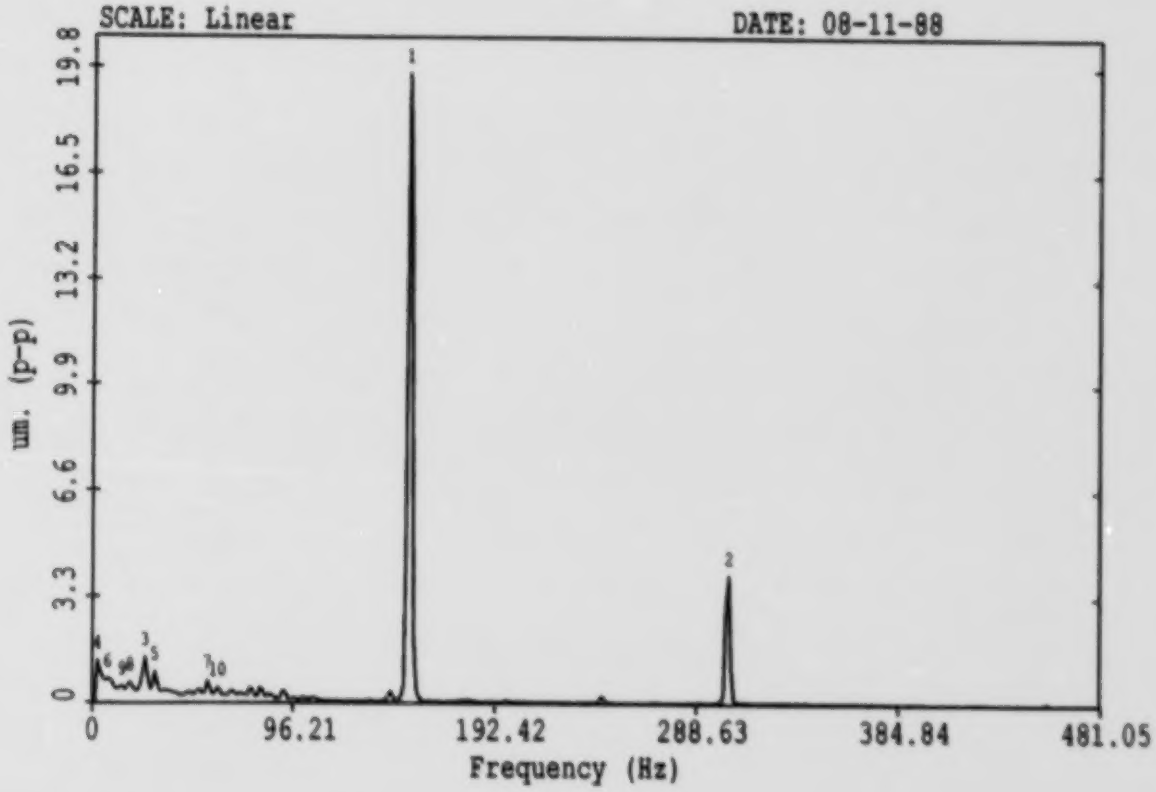


FIGURE F17

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #2 Shaft Displacement Vert.
PROCESS CONDITION : Load 1.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 151.5 | 19.63 |
| 2 | 304.3 | 4.00 |
| 3 | 25.3 | 1.44 |
| 4 | 2.4 | 1.33 |
| 5 | 30.1 | 0.97 |
| 6 | 7.2 | 0.76 |
| 7 | 55.3 | 0.70 |
| 8 | 18.0 | 0.65 |
| 9 | 14.4 | 0.53 |
| 10 | 60.1 | 0.50 |


SCALE: Linear

DATE: 08-11-88

FIGURE F18

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #2 Shaft Displacement Vert.
PROCESS CONDITION : Load 2.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 155.1 | 20.84 |
| 2 | 311.5 | 4.29 |
| 3 | 30.1 | 1.23 |
| 4 | 24.1 | 1.13 |
| 5 | 60.1 | 0.98 |
| 6 | 7.2 | 0.65 |
| 7 | 4.8 | 0.65 |
| 8 | 2.4 | 0.64 |
| 9 | 16.8 | 0.51 |
| 10 | 13.2 | 0.50 |

SCALE: Linear

DATE: 08-11-88

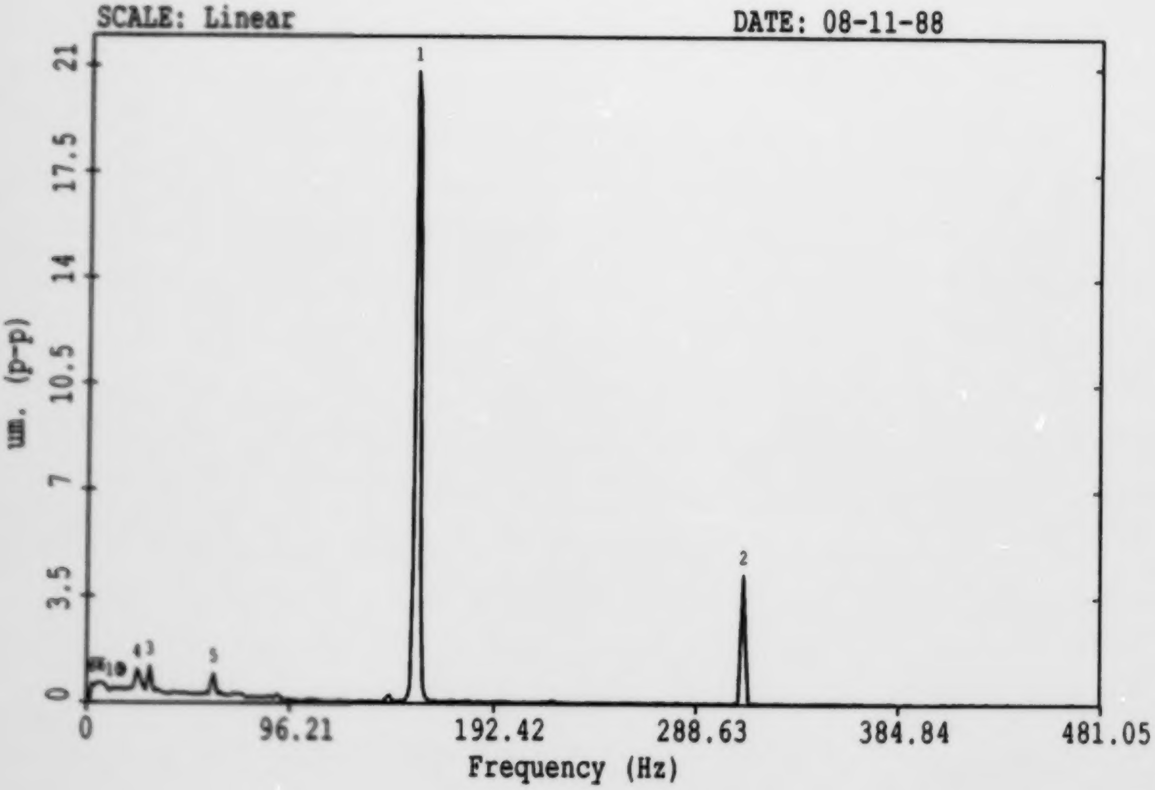


FIGURE F19

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #2 Shaft Displacement Vert.
PROCESS CONDITION : Load 3.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 158.7 | 21.97 |
| 2 | 316.3 | 4.55 |
| 3 | 30.1 | 1.09 |
| 4 | 2.4 | 1.00 |
| 5 | 24.1 | 0.92 |
| 6 | 60.1 | 0.71 |
| 7 | 8.4 | 0.62 |
| 8 | 34.9 | 0.53 |
| 9 | 13.2 | 0.48 |

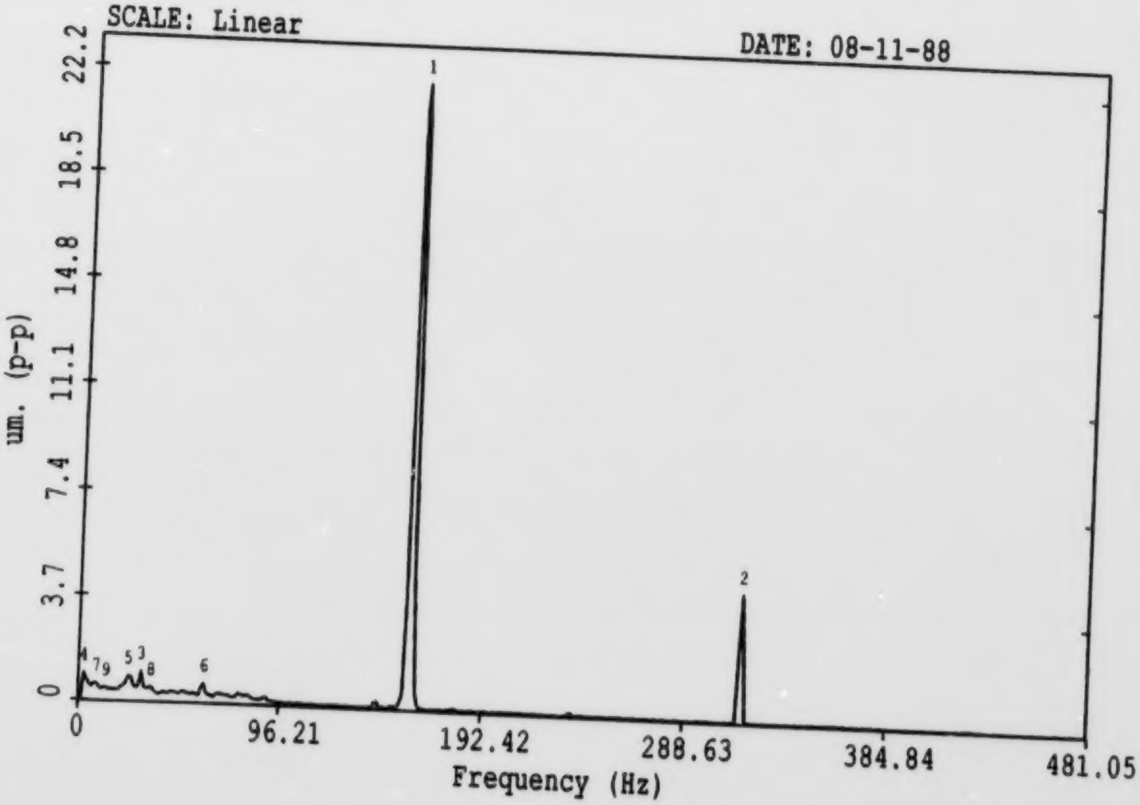


FIGURE F20

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #2 Shaft Displacement Vert.
PROCESS CONDITION : Load 4.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 160.0 | 22.63 |
| 2 | 321.1 | 4.45 |
| 3 | 25.3 | 1.63 |
| 4 | 30.1 | 0.93 |
| 5 | 2.4 | 0.68 |
| 6 | 16.8 | 0.63 |
| 7 | 19.2 | 0.57 |
| 8 | 72.2 | 0.57 |
| 9 | 4.8 | 0.55 |
| 10 | 33.7 | 0.53 |

SCALE: Linear

DATE: 08-11-88

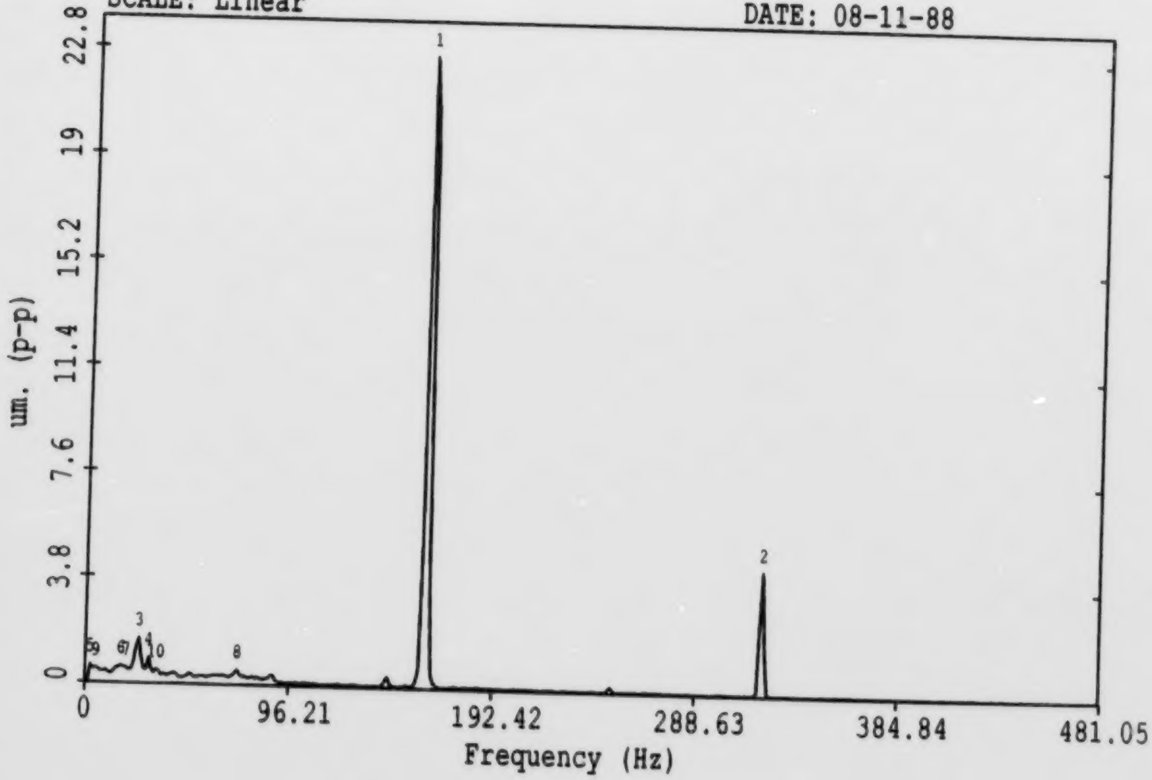


FIGURE F21

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #2 Shaft Displacement Vert.
PROCESS CONDITION : Load 5.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 162.4 | 28.70 |
| 2 | 324.7 | 4.52 |
| 3 | 98.6 | 0.97 |
| 4 | 25.3 | 0.95 |
| 5 | 30.1 | 0.87 |
| 6 | 63.7 | 0.64 |
| 7 | 18.0 | 0.60 |

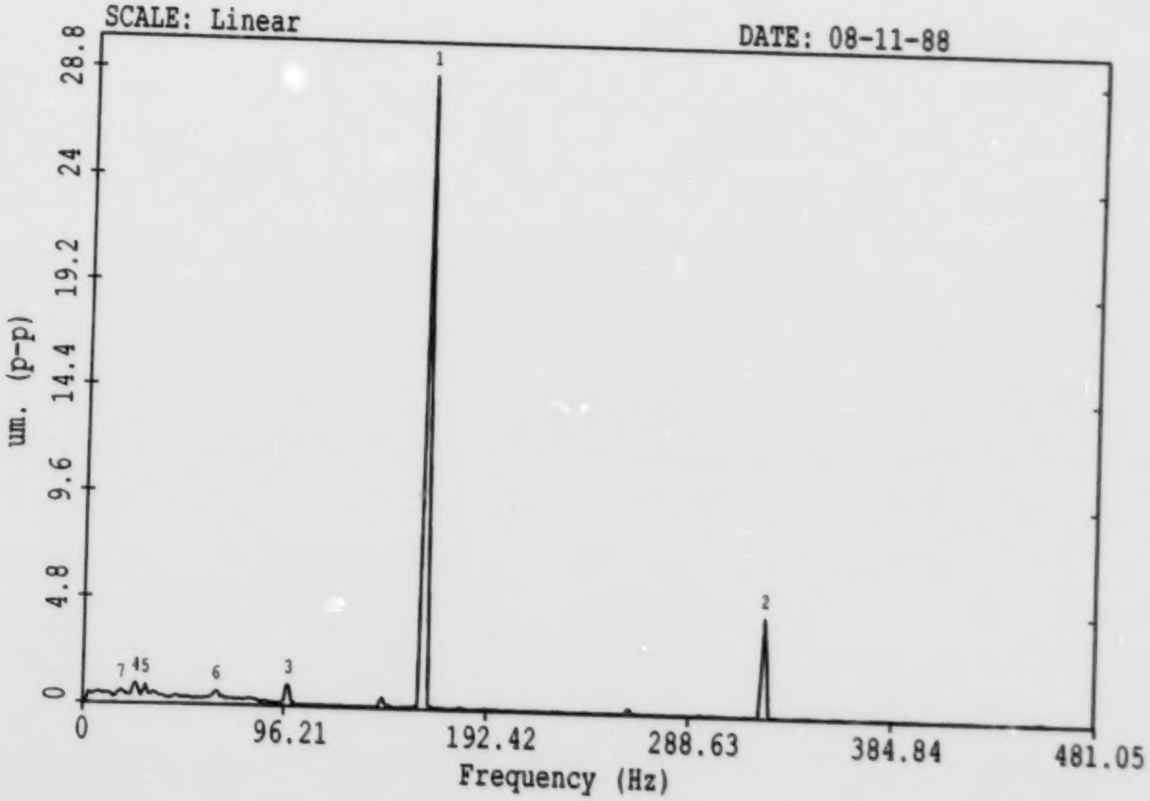


FIGURE F22

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #2 Shaft Displacement Vert.
PROCESS CONDITION : Load 6.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 167.2 | 25.32 |
| 2 | 333.1 | 4.49 |
| 3 | 25.3 | 1.00 |
| 4 | 30.1 | 0.81 |
| 5 | 19.2 | 0.75 |
| 6 | 34.9 | 0.54 |

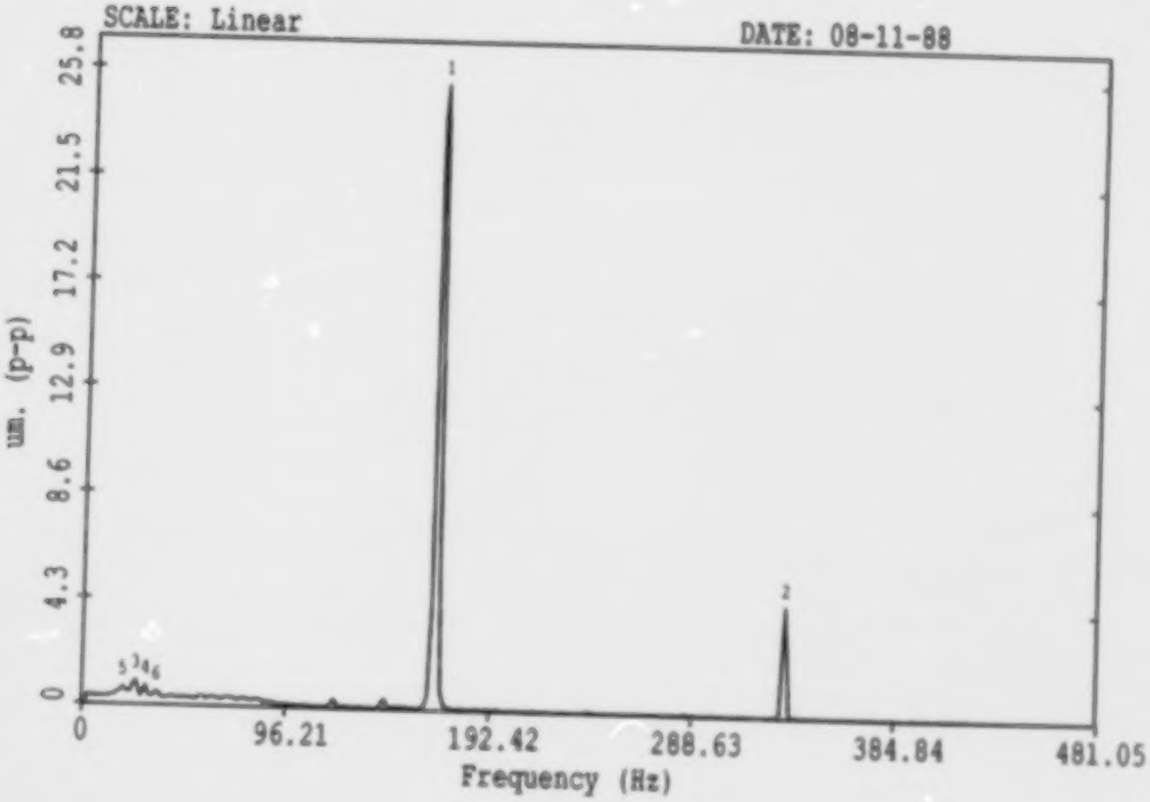


FIGURE F23

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #2 Shaft Displacement Vert.
PROCESS CONDITION : Load 6.9 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 170.8 | 25.37 |
| 2 | 342.8 | 4.20 |
| 3 | 25.3 | 1.10 |
| 4 | 30.1 | 0.91 |
| 5 | 21.6 | 0.83 |
| 6 | 64.9 | 0.59 |
| 7 | 71.0 | 0.56 |

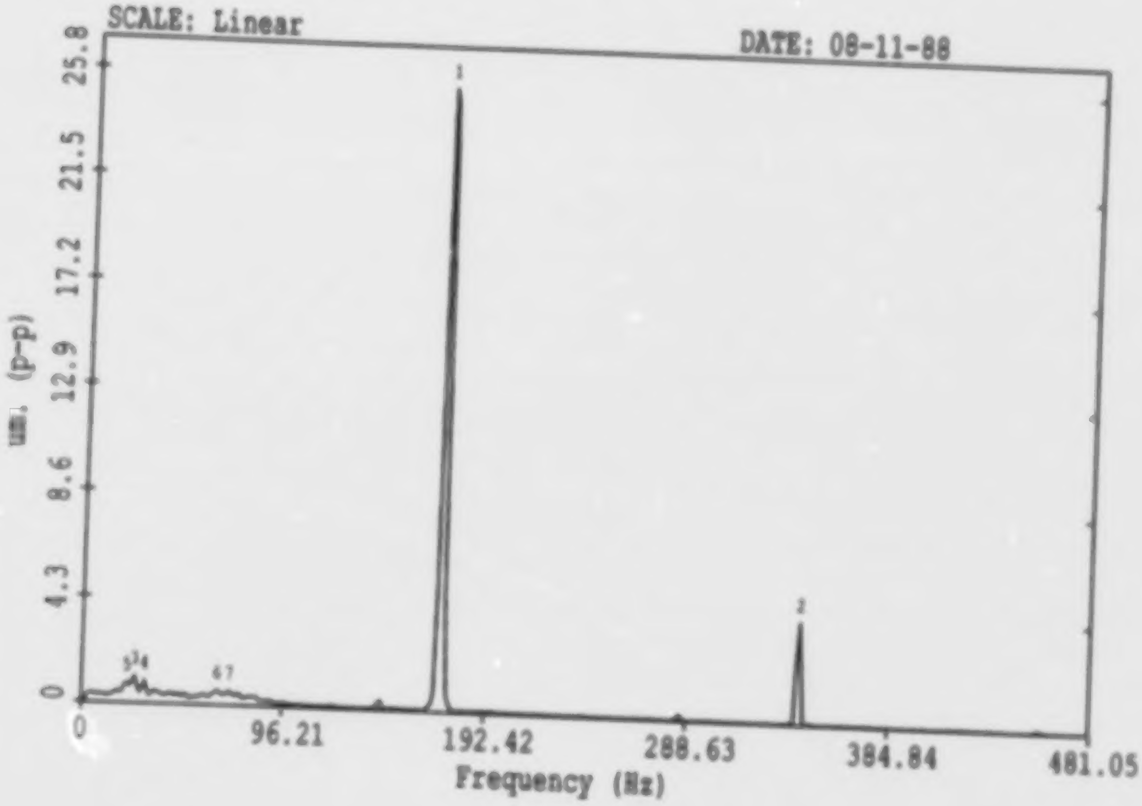


FIGURE F24

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #2 Shaft Displacement Horiz.
PROCESS CONDITION : Load 0.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 147.9 | 17.76 |
| 2 | 297.1 | 2.58 |
| 3 | 30.1 | 0.85 |
| 4 | 22.9 | 0.84 |
| 5 | 4.8 | 0.60 |
| 6 | 10.8 | 0.46 |
| 7 | 18.0 | 0.44 |
| 8 | 26.5 | 0.43 |
| 9 | 83.0 | 0.40 |

SCALE: Linear

DATE: 08-11-88

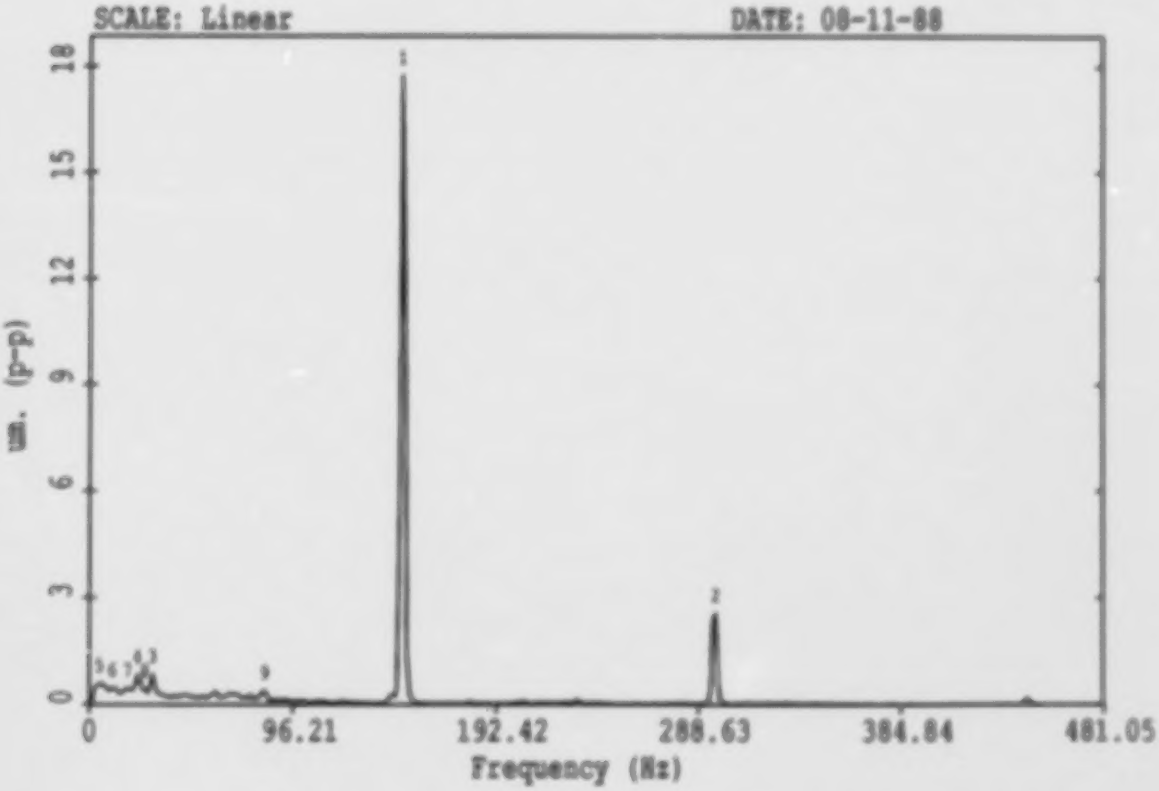


FIGURE F25

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #2 Shaft Displacement Horiz.
PROCESS CONDITION : Load 1.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 151.5 | 19.82 |
| 2 | 304.3 | 2.69 |
| 3 | 2.4 | 1.38 |
| 4 | 25.3 | 1.21 |
| 5 | 30.1 | 1.04 |
| 6 | 7.2 | 0.80 |
| 7 | 60.1 | 0.53 |
| 8 | 75.8 | 0.51 |
| 9 | 55.3 | 0.51 |
| 10 | 18.0 | 0.49 |

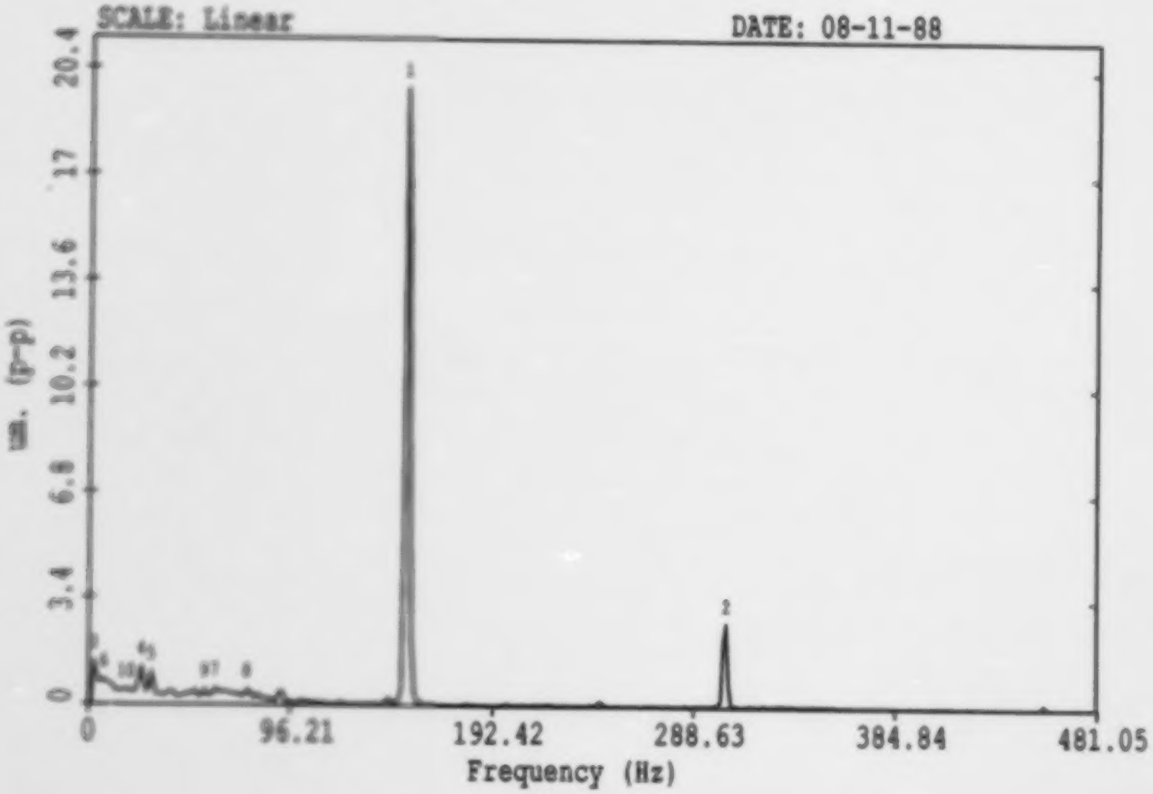

SCALE: Linear
DATE: 08-11-88

FIGURE F26

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #2 Shaft Displacement Horiz.
PROCESS CONDITION : Load 2.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 155.1 | 20.32 |
| 2 | 311.5 | 2.80 |
| 3 | 30.1 | 1.33 |
| 4 | 60.1 | 1.18 |
| 5 | 24.1 | 0.87 |
| 6 | 6.0 | 0.71 |
| 7 | 2.4 | 0.70 |
| 8 | 9.6 | 0.61 |
| 9 | 18.0 | 0.58 |

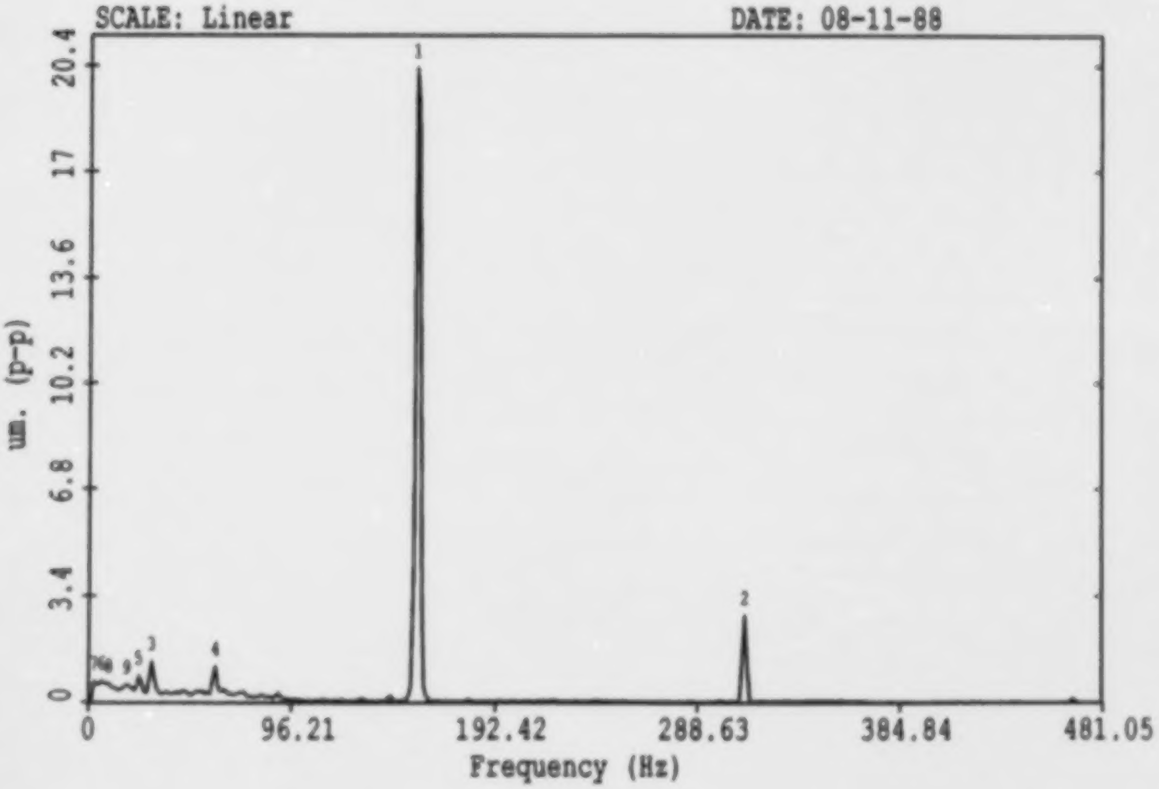
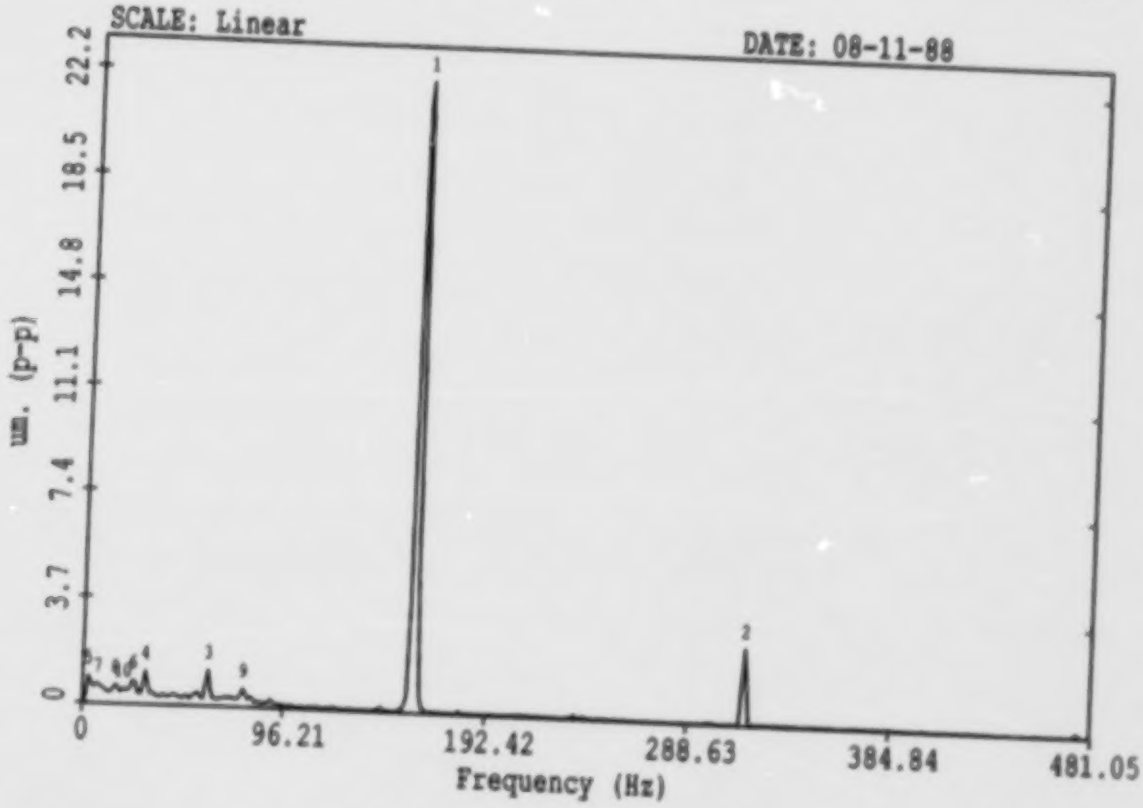


FIGURE F27

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #2 Shaft Displacement Horiz.
PROCESS CONDITION : Load 3.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 158.7 | 22.07 |
| 2 | 316.3 | 2.69 |
| 3 | 60.1 | 1.26 |
| 4 | 30.1 | 1.19 |
| 5 | 2.4 | 0.97 |
| 6 | 24.1 | 0.85 |
| 7 | 7.2 | 0.69 |
| 8 | 15.6 | 0.67 |
| 9 | 77.0 | 0.67 |
| 10 | 19.2 | 0.55 |


SCALE: Linear

DATE: 08-11-88

FIGURE F28

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #2 Shaft Displacement Horiz.
PROCESS CONDITION : Load 4.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 160.0 | 22.98 |
| 2 | 321.1 | 2.47 |
| 3 | 30.1 | 1.21 |
| 4 | 60.1 | 1.17 |
| 5 | 25.3 | 1.00 |
| 6 | 89.0 | 0.90 |
| 7 | 18.0 | 0.65 |
| 8 | 72.2 | 0.62 |
| 9 | 4.8 | 0.53 |
| 10 | 2.4 | 0.53 |

SCALE: Linear

DATE: 08-11-88

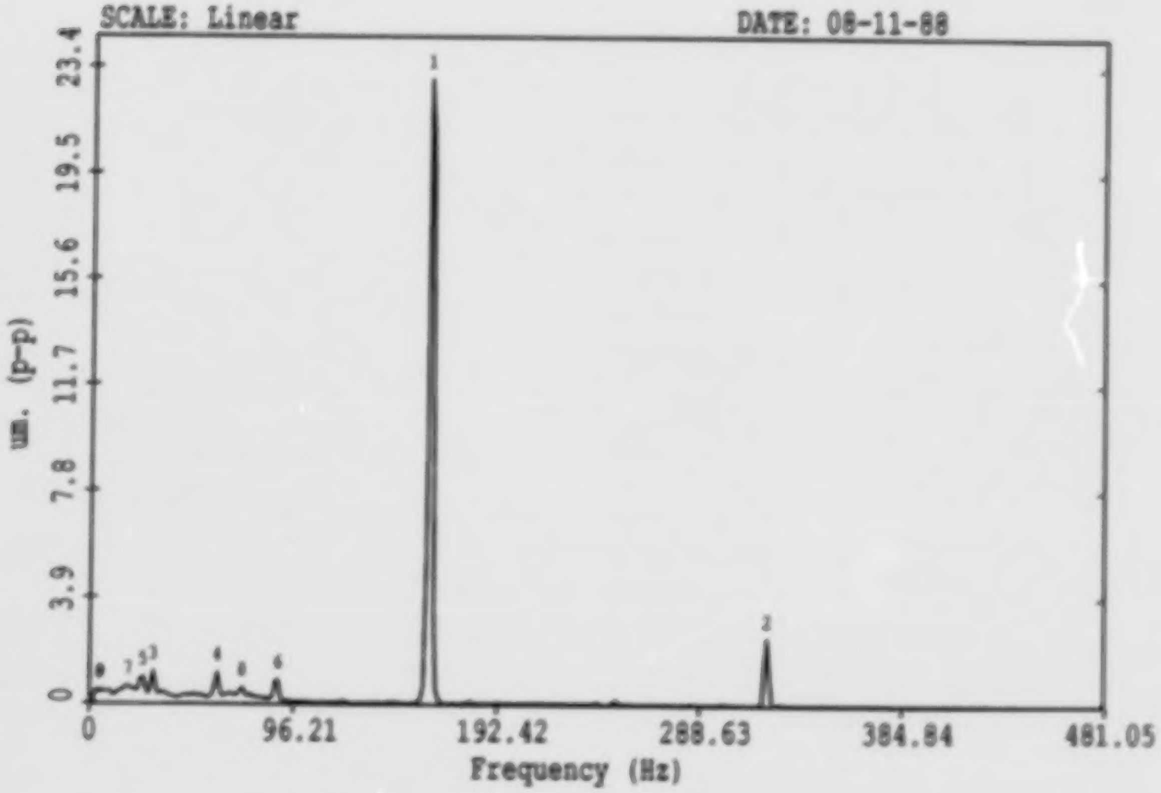


FIGURE F29

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #2 Shaft Displacement Horiz.
PROCESS CONDITION : Load 5.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 162.4 | 29.14 |
| 2 | 324.7 | 2.40 |
| 3 | 98.6 | 1.61 |
| 4 | 30.1 | 1.22 |
| 5 | 60.1 | 0.91 |
| 6 | 25.3 | 0.90 |
| 7 | 64.9 | 0.62 |

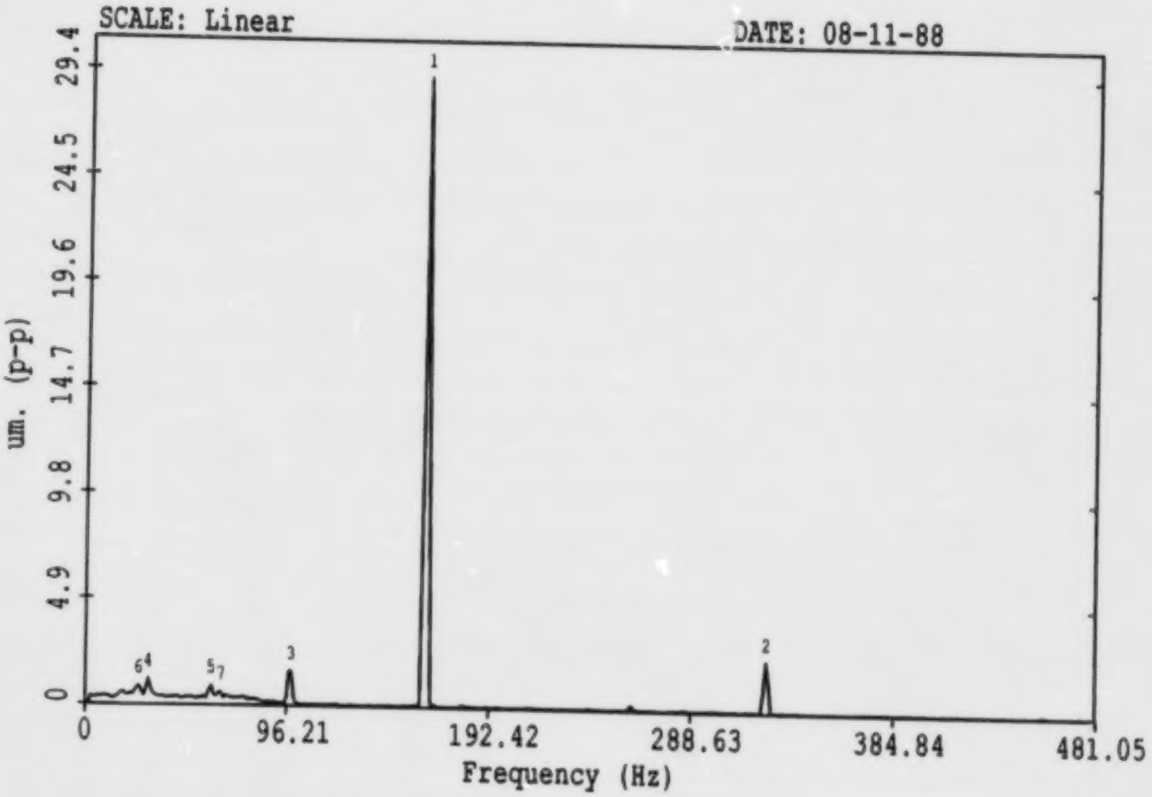


FIGURE F30

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #2 Shaft Displacement Horiz.
PROCESS CONDITION : Load 6.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 167.2 | 25.60 |
| 2 | 333.1 | 2.38 |
| 3 | 30.1 | 1.19 |
| 4 | 60.1 | 1.09 |
| 5 | 25.3 | 0.92 |
| 6 | 20.4 | 0.73 |
| 7 | 75.8 | 0.54 |

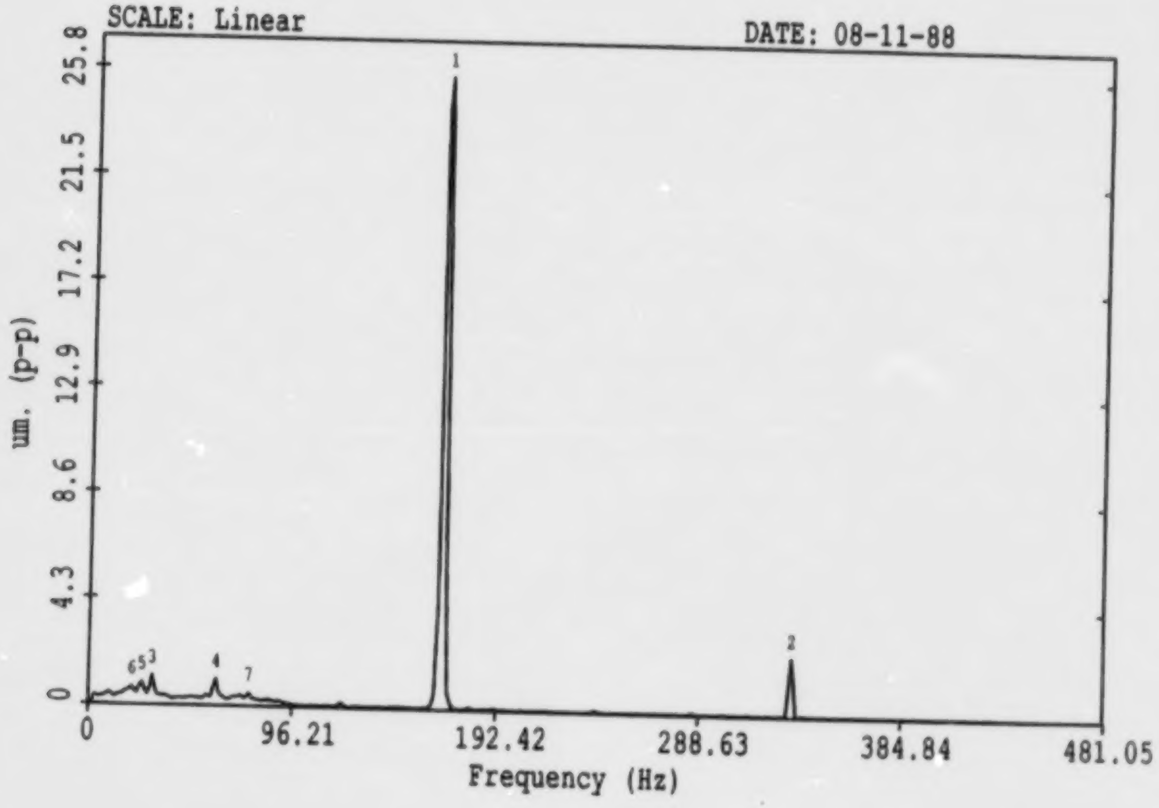


FIGURE F31

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #2 Shaft Displacement Horiz.
PROCESS CONDITION : Load 6.9 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 170.8 | 25.94 |
| 2 | 342.8 | 2.32 |
| 3 | 30.1 | 1.12 |
| 4 | 60.1 | 0.95 |
| 5 | 24.1 | 0.92 |
| 6 | 75.8 | 0.68 |
| 7 | 71.0 | 0.57 |

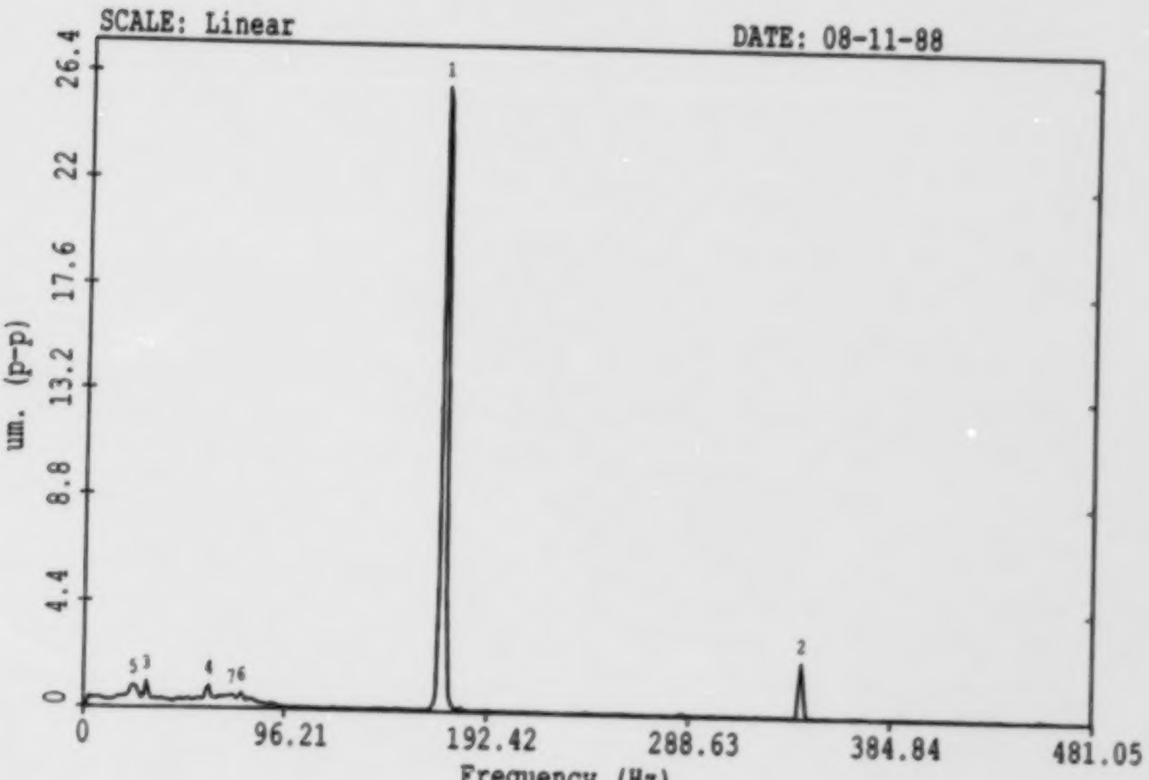


FIGURE F32

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #3 Shaft Displacement Vert.
PROCESS CONDITION : Load 0.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 147.9 | 7.25 |
| 2 | 297.1 | 1.17 |
| 3 | 60.1 | 0.82 |
| 4 | 9.6 | 0.70 |
| 5 | 445.0 | 0.65 |
| 6 | 2.4 | 0.63 |
| 7 | 14.4 | 0.57 |
| 8 | 21.6 | 0.55 |
| 9 | 18.0 | 0.50 |
| 10 | 143.1 | 0.48 |

SCALE: Linear DATE: 08-11-88

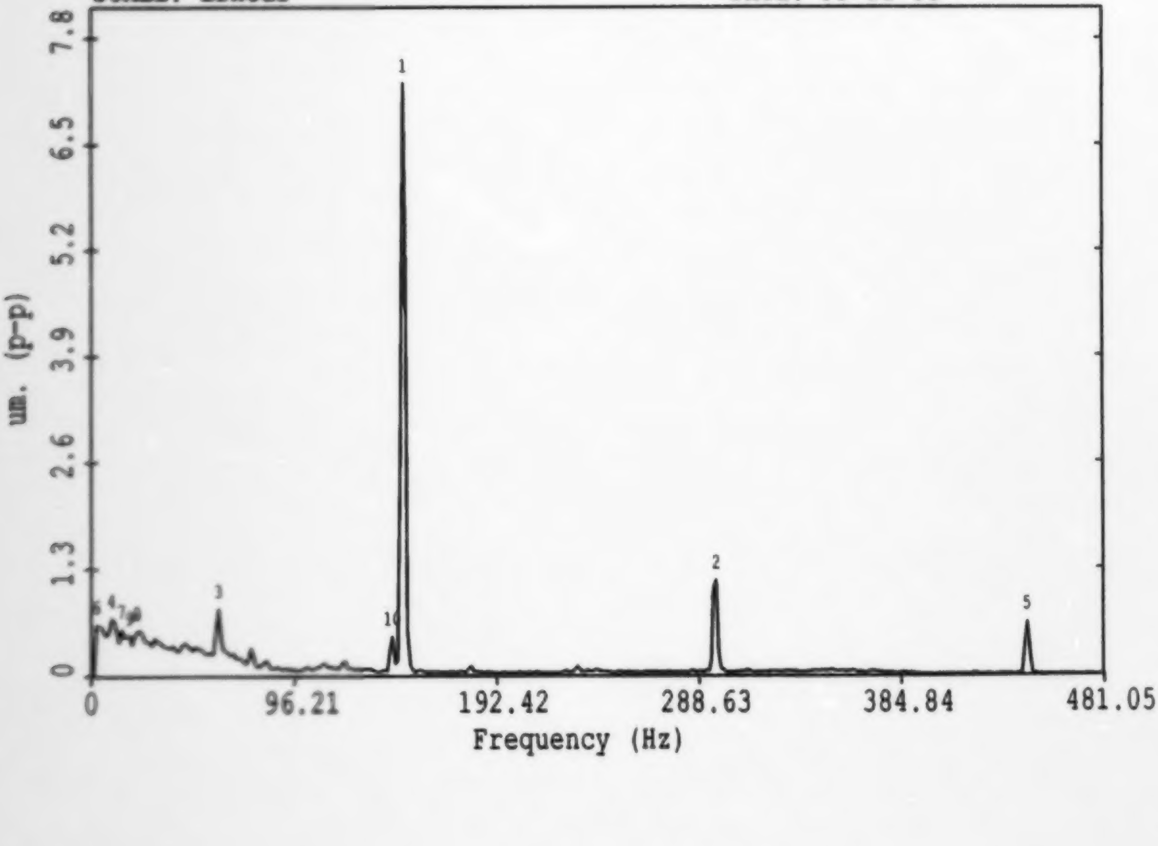


FIGURE F33

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #3 Shaft Displacement Vert.
PROCESS CONDITION : Load 1.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 151.5 | 8.84 |
| 2 | 2.4 | 1.33 |
| 3 | 304.3 | 1.17 |
| 4 | 14.4 | 0.85 |
| 5 | 12.0 | 0.78 |
| 6 | 55.3 | 0.74 |
| 7 | 7.2 | 0.71 |
| 8 | 50.5 | 0.67 |
| 9 | 455.8 | 0.63 |
| 10 | 25.3 | 0.61 |

SCALE: Linear

DATE: 08-11-88

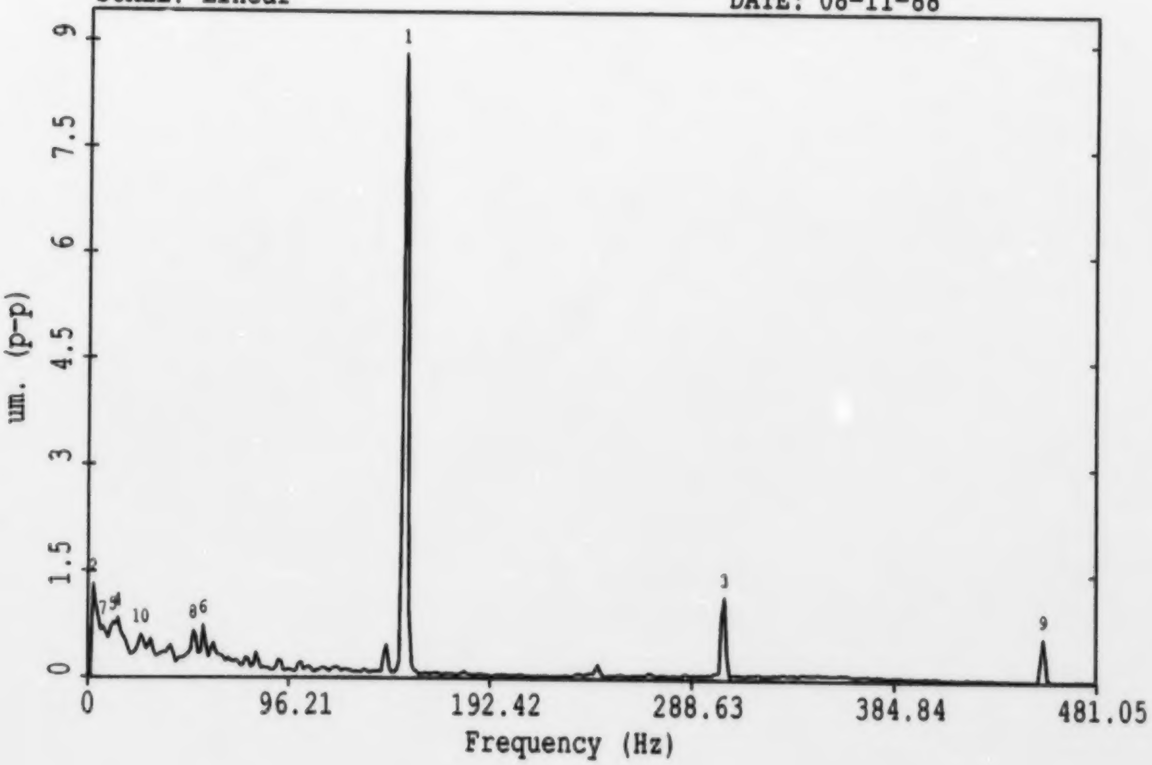


FIGURE F34

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #3 Shaft Displacement Vert.
PROCESS CONDITION : Load 2.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 155.1 | 10.80 |
| 2 | 60.1 | 1.60 |
| 3 | 311.5 | 1.19 |
| 4 | 16.8 | 0.97 |
| 5 | 30.1 | 0.72 |
| 6 | 2.4 | 0.61 |
| 7 | 24.1 | 0.60 |
| 8 | 466.6 | 0.55 |
| 9 | 4.8 | 0.52 |
| 10 | 7.2 | 0.50 |

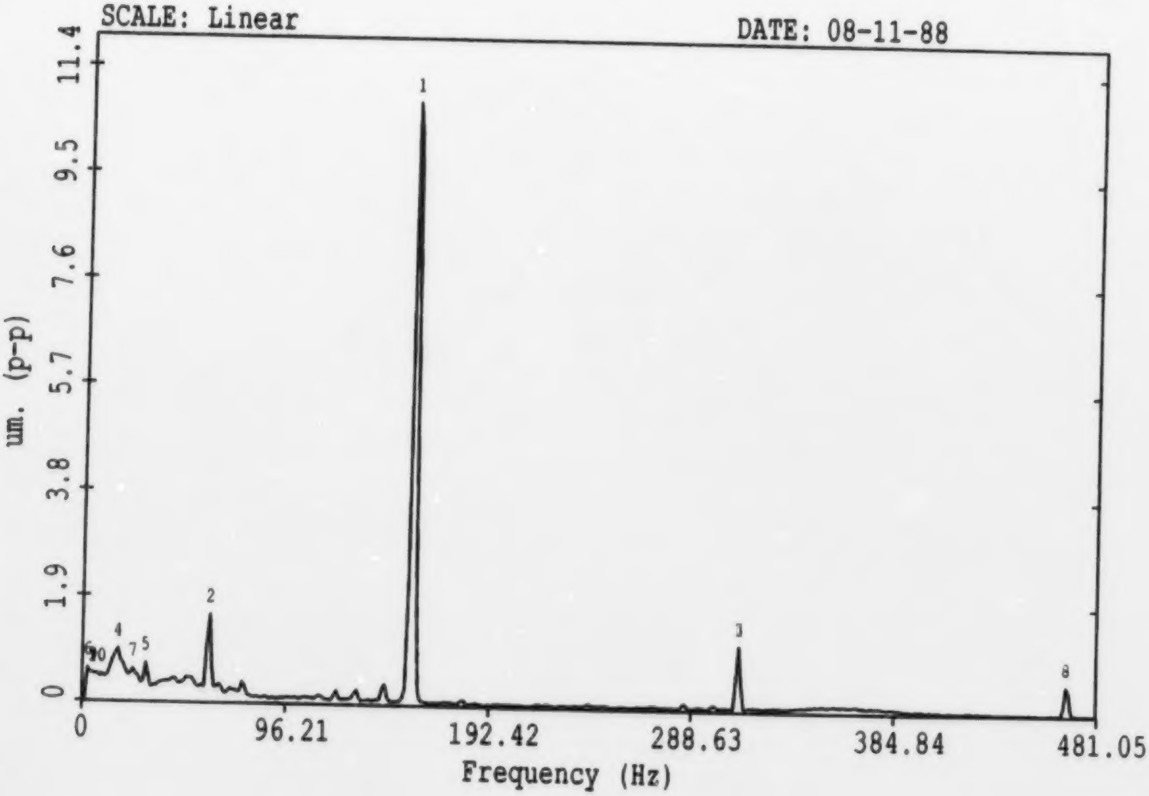


FIGURE F35

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #3 Shaft Displacement Vert.
PROCESS CONDITION : Load 3.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 158.7 | 12.48 |
| 2 | 60.1 | 1.56 |
| 3 | 316.3 | 1.32 |
| 4 | 2.4 | 0.95 |
| 5 | 16.8 | 0.92 |
| 6 | 30.1 | 0.75 |
| 7 | 7.2 | 0.60 |
| 8 | 475.0 | 0.55 |
| 9 | 25.3 | 0.53 |
| 10 | 22.9 | 0.52 |

SCALE: Linear

DATE: 08-11-88

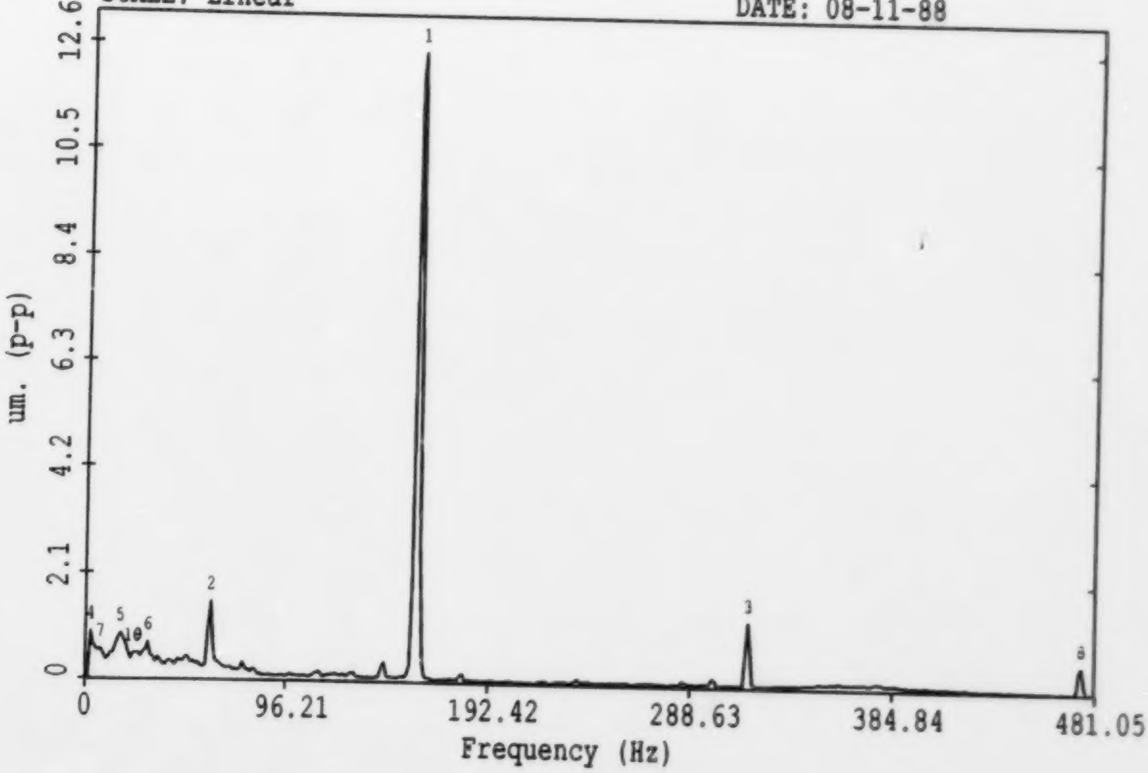


FIGURE F36

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #3 Shaft Displacement Vert.
PROCESS CONDITION : Load 4.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 160.0 | 13.38 |
| 2 | 321.1 | 1.26 |
| 3 | 60.1 | 1.25 |
| 4 | 16.8 | 0.76 |
| 5 | 19.2 | 0.75 |
| 6 | 30.1 | 0.74 |
| 7 | 143.1 | 0.60 |
| 8 | 25.3 | 0.58 |
| 9 | 13.2 | 0.57 |
| 10 | 2.4 | 0.52 |

SCALE: Linear

DATE: 08-11-88

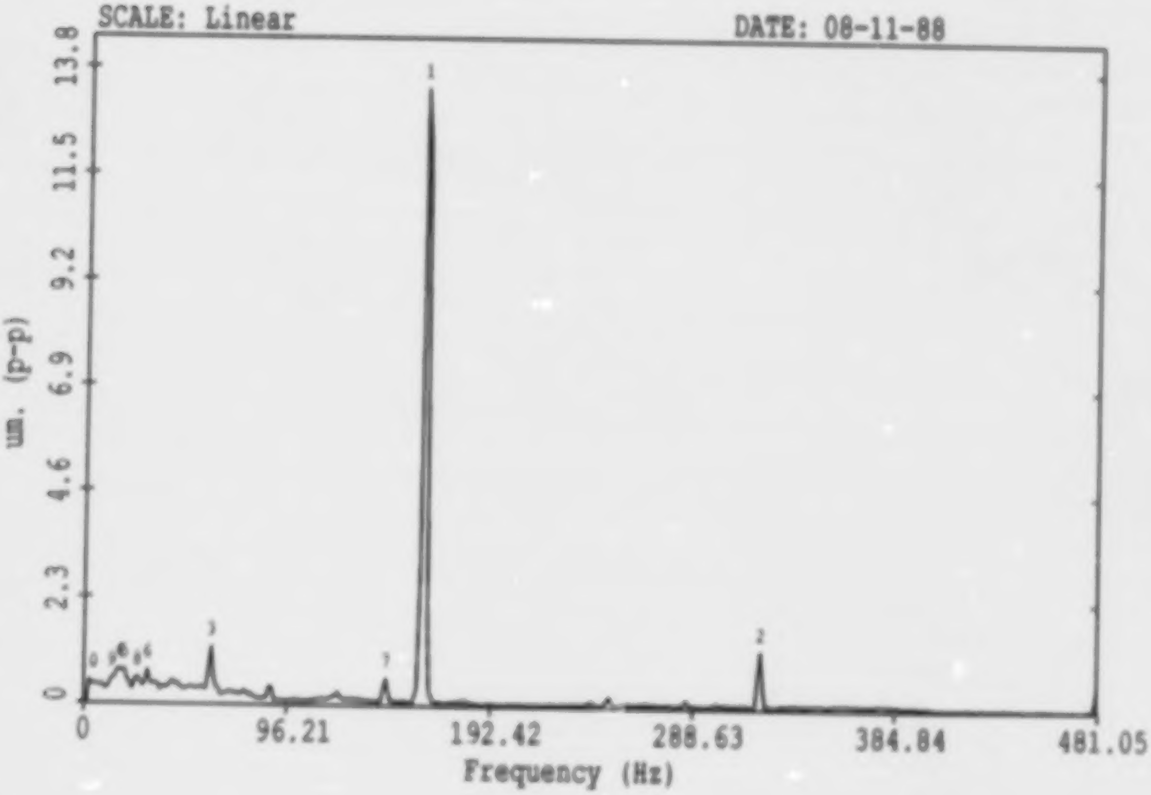


FIGURE F37

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #3 Shaft Displacement Vert.
PROCESS CONDITION : Load 5.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 162.4 | 15.82 |
| 2 | 60.1 | 1.28 |
| 3 | 324.7 | 1.28 |
| 4 | 16.8 | 1.03 |
| 5 | 30.1 | 0.77 |
| 6 | 143.1 | 0.66 |
| 7 | 98.6 | 0.61 |
| 8 | 24.1 | 0.54 |
| 9 | 44.5 | 0.54 |
| 10 | 10.8 | 0.52 |

SCALE: Linear

DATE: 08-11-88

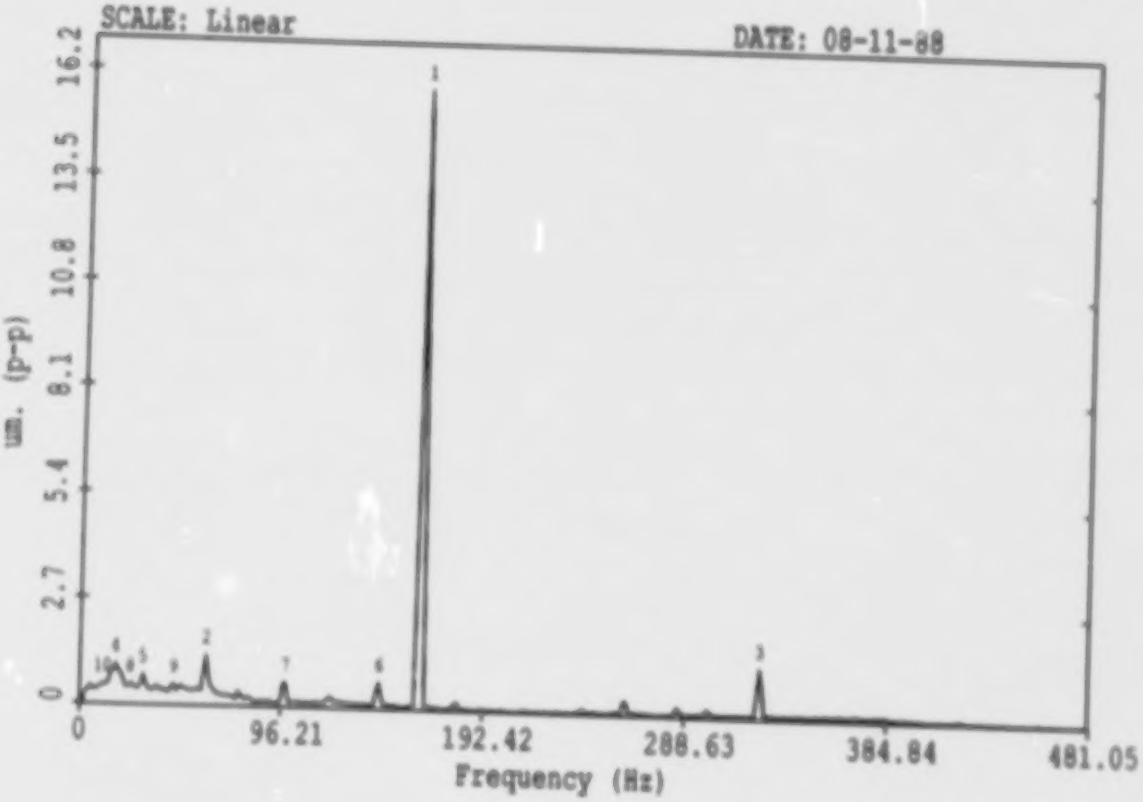


FIGURE F38

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #3 Shaft Displacement Vert.
PROCESS CONDITION : Load 6.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 167.2 | 13.86 |
| 2 | 333.1 | 1.18 |
| 3 | 60.1 | 1.01 |
| 4 | 16.8 | 0.86 |
| 5 | 30.1 | 0.75 |
| 6 | 143.1 | 0.66 |
| 7 | 6.0 | 0.56 |
| 8 | 42.1 | 0.53 |
| 9 | 25.3 | 0.50 |
| 10 | 45.7 | 0.49 |

SCALE: Linear

DATE: 08-11-88

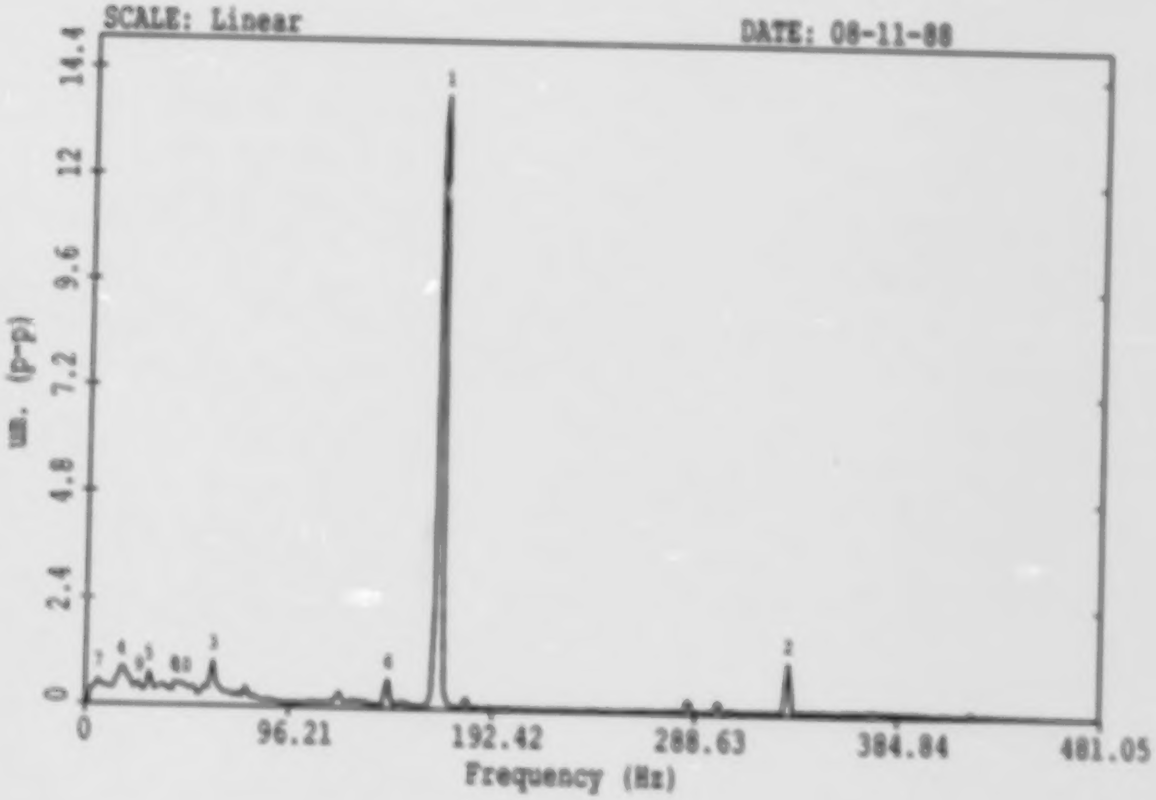
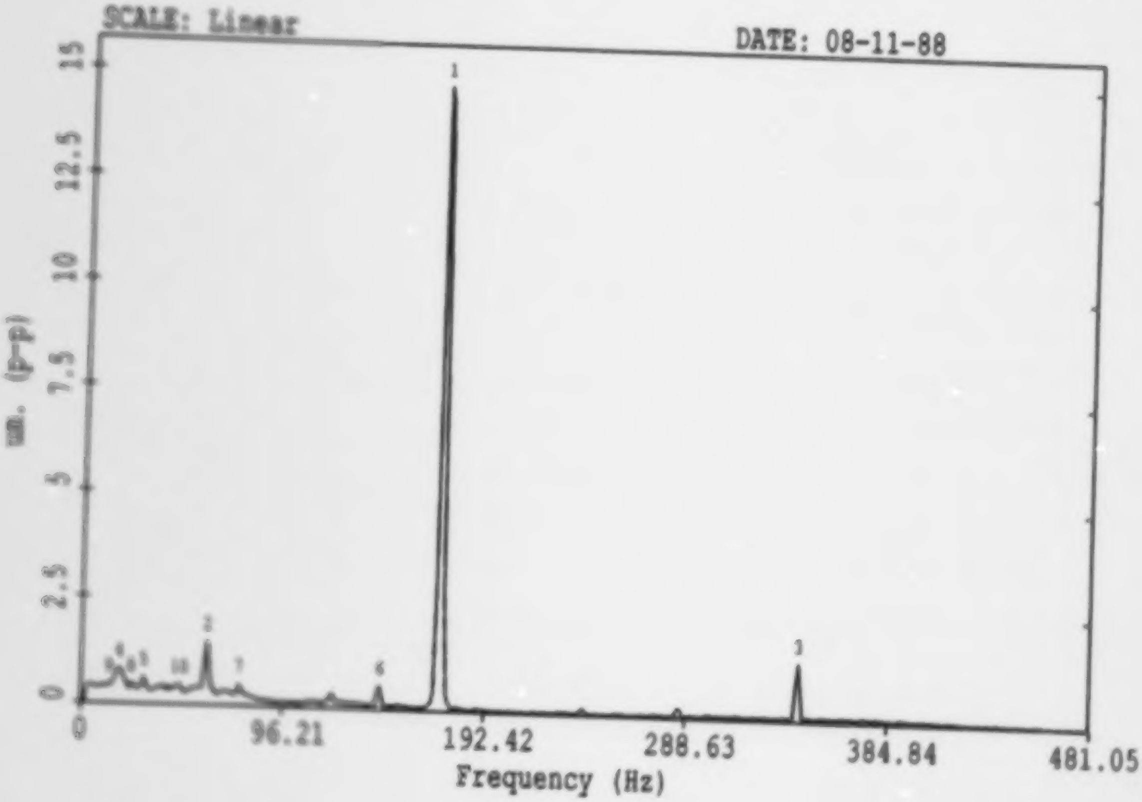


FIGURE F39

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #3 Shaft Displacement Vert.
PROCESS CONDITION : Load 6.9 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 170.8 | 14.73 |
| 2 | 60.1 | 1.48 |
| 3 | 342.8 | 1.37 |
| 4 | 18.0 | 0.82 |
| 5 | 30.1 | 0.63 |
| 6 | 143.1 | 0.55 |
| 7 | 75.8 | 0.50 |
| 8 | 24.1 | 0.48 |
| 9 | 13.2 | 0.47 |
| 10 | 46.9 | 0.46 |



SCALE: Linear

DATE: 08-11-88

FIGURE F40

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #3 Shaft Displacement Horiz.
PROCESS CONDITION : Load 0.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 147.9 | 7.34 |
| 2 | 297.1 | 1.19 |
| 3 | 445.0 | 0.68 |
| 4 | 30.1 | 0.64 |
| 5 | 3.6 | 0.48 |
| 6 | 143.1 | 0.39 |
| 7 | 60.1 | 0.38 |
| 8 | 22.9 | 0.31 |
| 9 | 12.0 | 0.26 |
| 10 | 75.8 | 0.25 |

SCALE: Linear DATE: 08-11-88

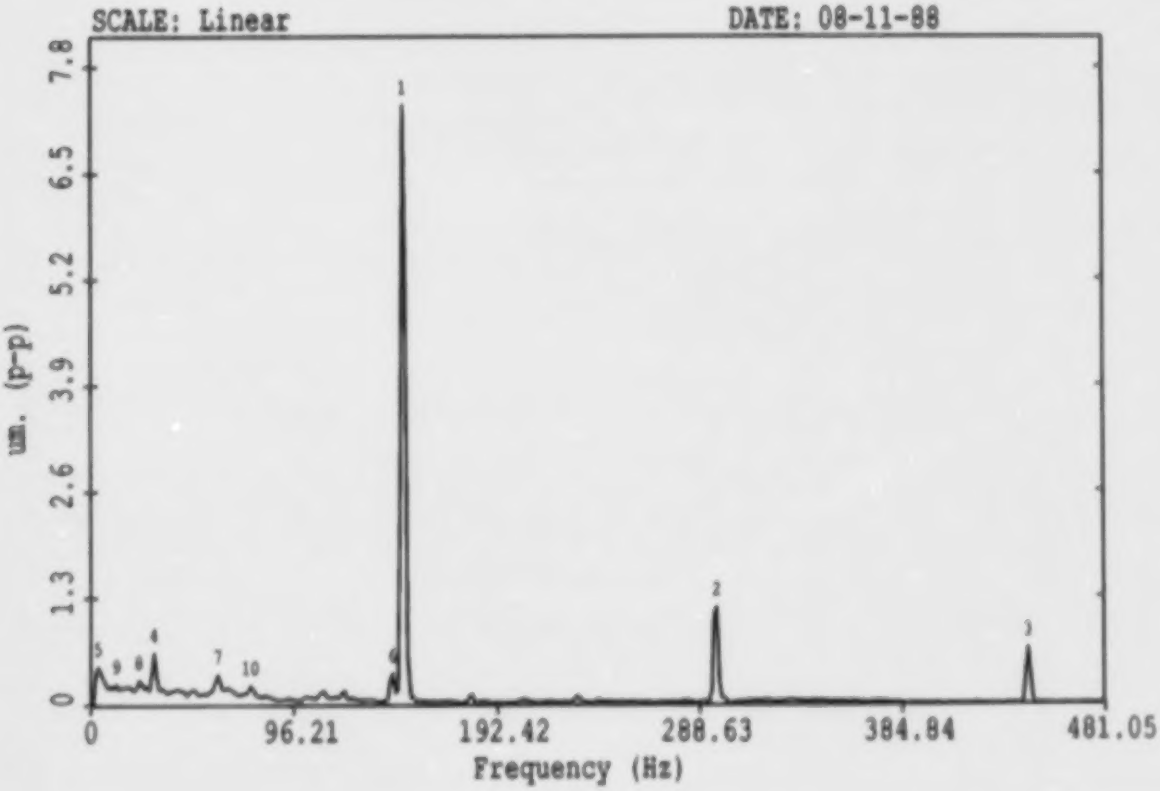


FIGURE F41

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #3 Shaft Displacement Horiz.
PROCESS CONDITION : Load 1.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 151.5 | 9.02 |
| 2 | 304.3 | 1.28 |
| 3 | 2.4 | 1.24 |
| 4 | 30.1 | 0.85 |
| 5 | 455.8 | 0.66 |
| 6 | 25.3 | 0.66 |
| 7 | 60.1 | 0.56 |
| 8 | 7.2 | 0.50 |
| 9 | 143.1 | 0.39 |
| 10 | 77.0 | 0.33 |

SCALE: Linear

DATE: 08-11-88

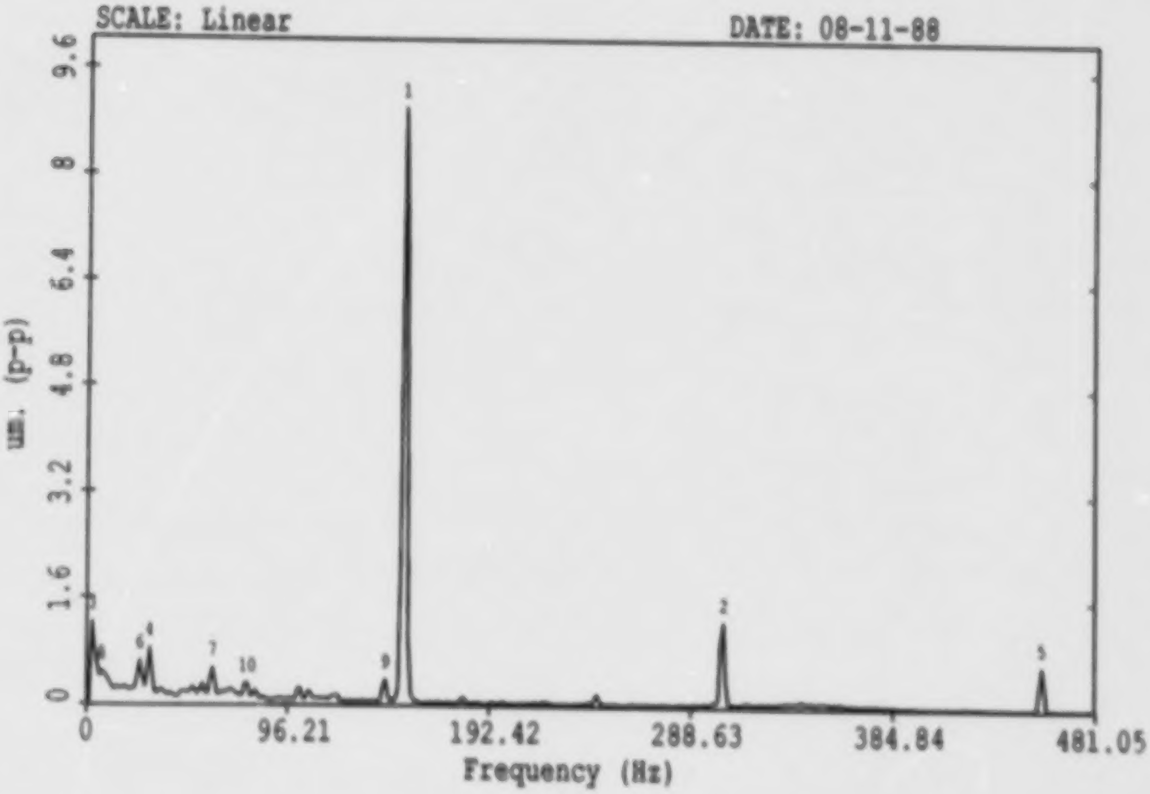


FIGURE F42

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #3 Shaft Displacement Horiz.
PROCESS CONDITION : Load 2.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 155.1 | 9.54 |
| 2 | 60.1 | 1.63 |
| 3 | 311.5 | 1.39 |
| 4 | 30.1 | 1.23 |
| 5 | 466.6 | 0.55 |
| 6 | 2.4 | 0.48 |
| 7 | 120.3 | 0.40 |
| 8 | 24.1 | 0.38 |
| 9 | 143.1 | 0.35 |
| 10 | 75.8 | 0.33 |

SCALE: Linear

DATE: 08-11-88

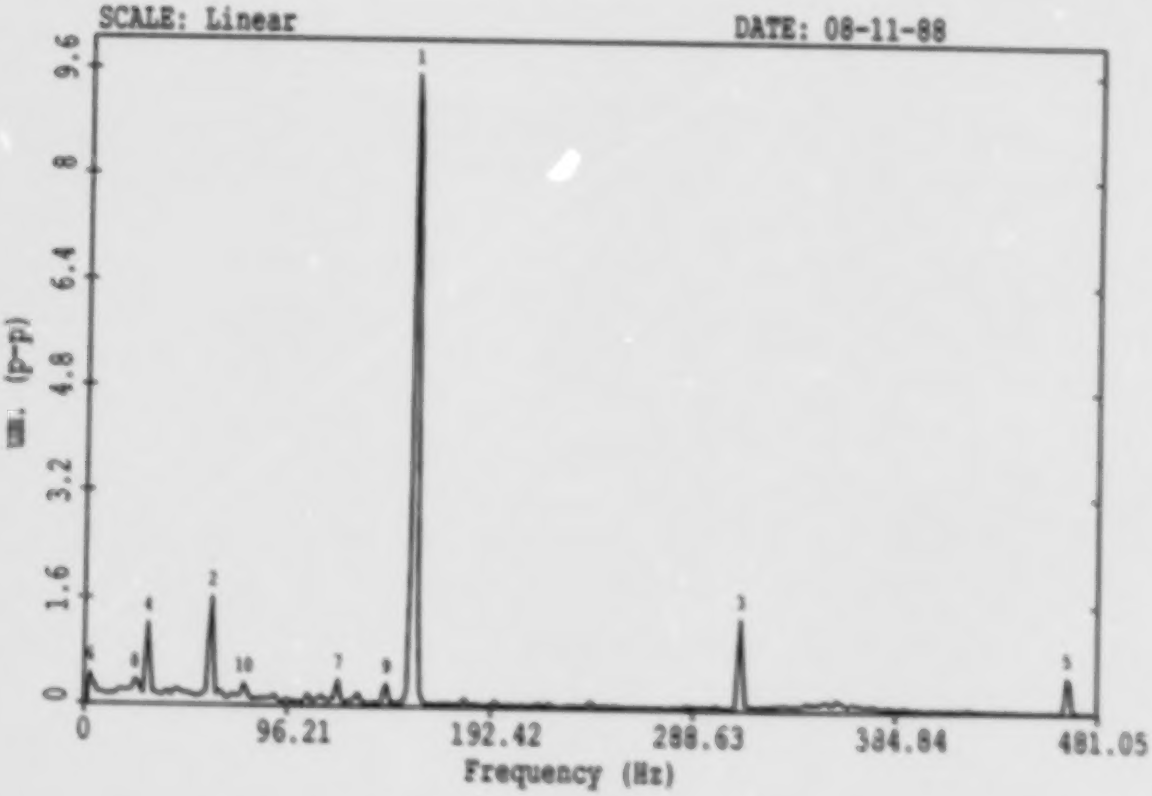
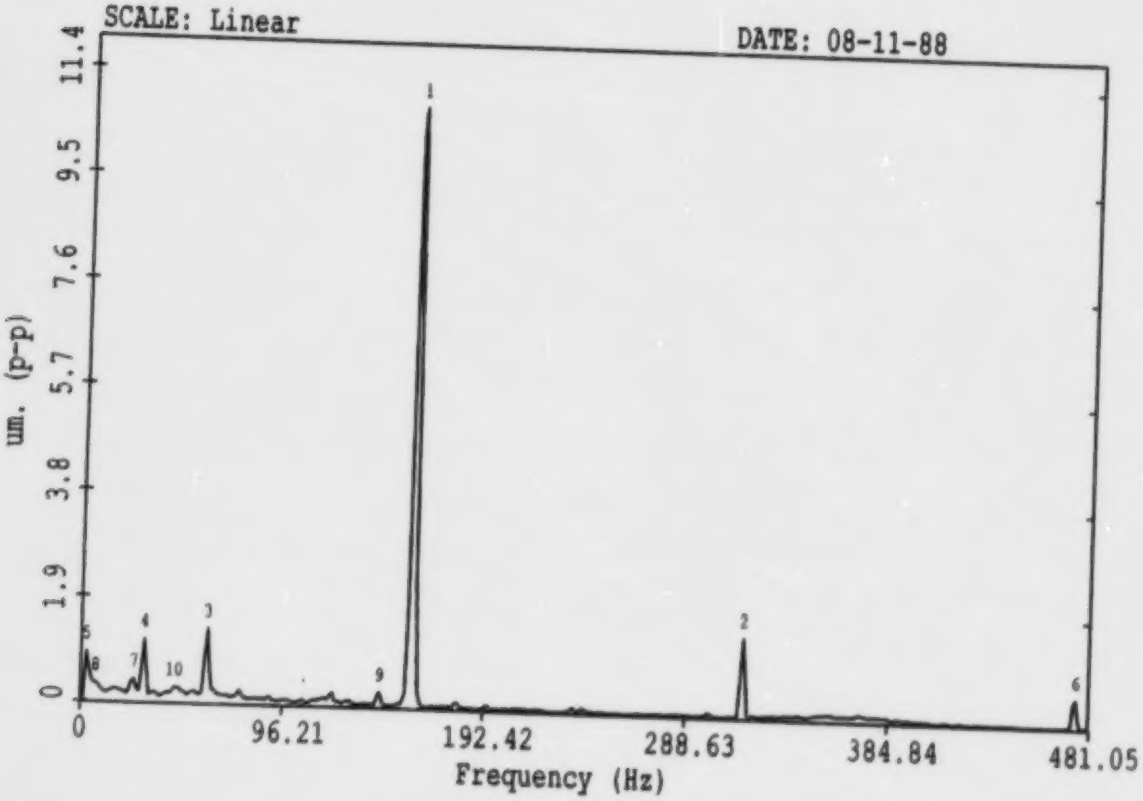


FIGURE F43

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #3 Shaft Displacement Horiz.
PROCESS CONDITION : Load 3.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 158.7 | 10.81 |
| 2 | 316.3 | 1.47 |
| 3 | 60.1 | 1.36 |
| 4 | 30.1 | 1.16 |
| 5 | 2.4 | 0.91 |
| 6 | 475.0 | 0.54 |
| 7 | 25.3 | 0.43 |
| 8 | 7.2 | 0.35 |
| 9 | 143.1 | 0.30 |
| 10 | 44.5 | 0.29 |


SCALE: Linear

DATE: 08-11-88

FIGURE F44

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #3 Shaft Displacement Horiz.
PROCESS CONDITION : Load 4.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 160.0 | 12.43 |
| 2 | 321.1 | 1.47 |
| 3 | 30.1 | 1.09 |
| 4 | 60.1 | 0.95 |
| 5 | 25.3 | 0.49 |
| 6 | 120.3 | 0.36 |
| 7 | 2.4 | 0.35 |
| 8 | 143.1 | 0.31 |
| 9 | 75.8 | 0.30 |

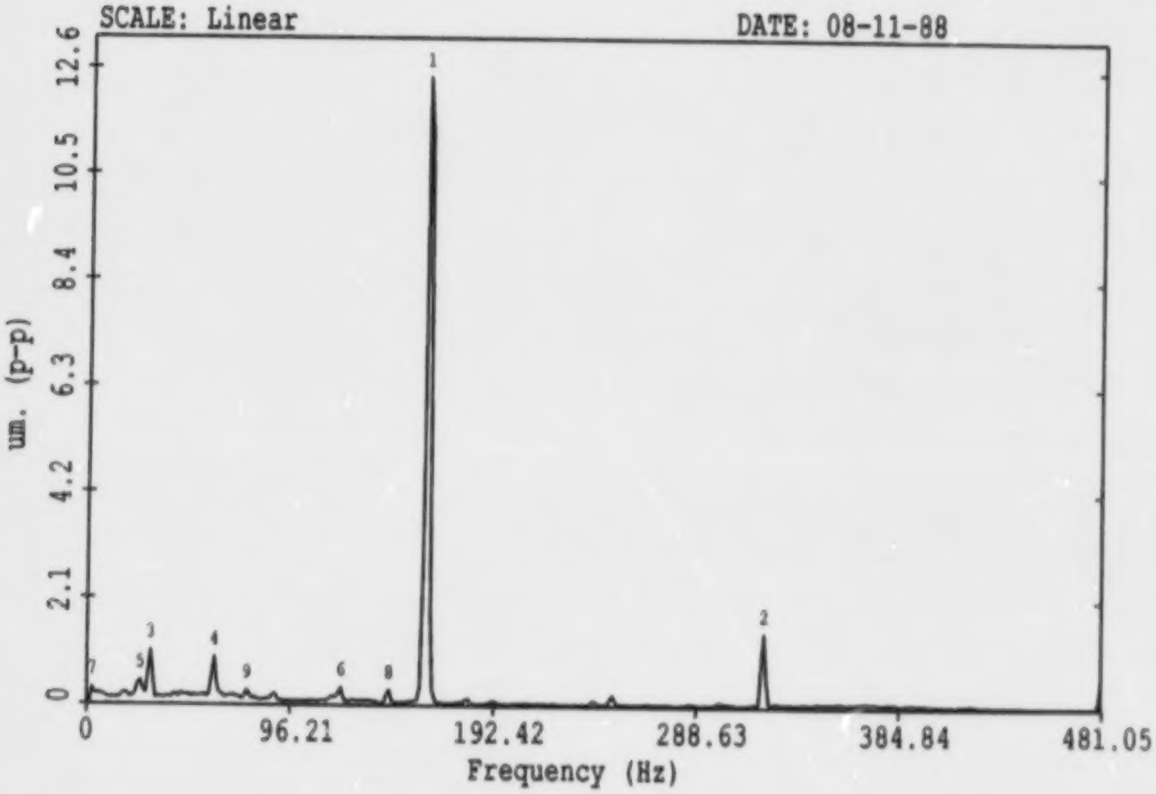


FIGURE F45

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #3 Shaft Displacement Horiz.
PROCESS CONDITION : Load 5.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 162.4 | 15.48 |
| 2 | 324.7 | 1.41 |
| 3 | 30.1 | 1.00 |
| 4 | 60.1 | 0.75 |
| 5 | 98.6 | 0.68 |
| 6 | 143.1 | 0.46 |
| 7 | 25.3 | 0.42 |
| 8 | 120.3 | 0.34 |
| 9 | 75.8 | 0.34 |
| 10 | 261.0 | 0.33 |

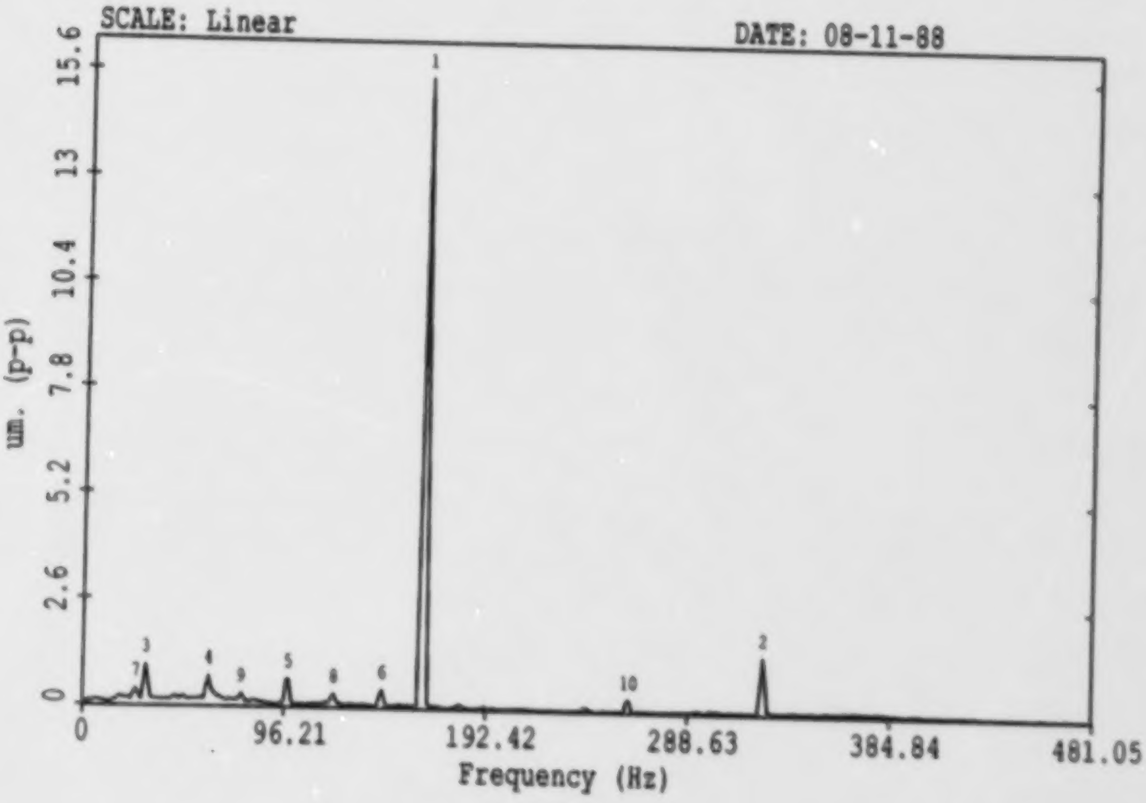
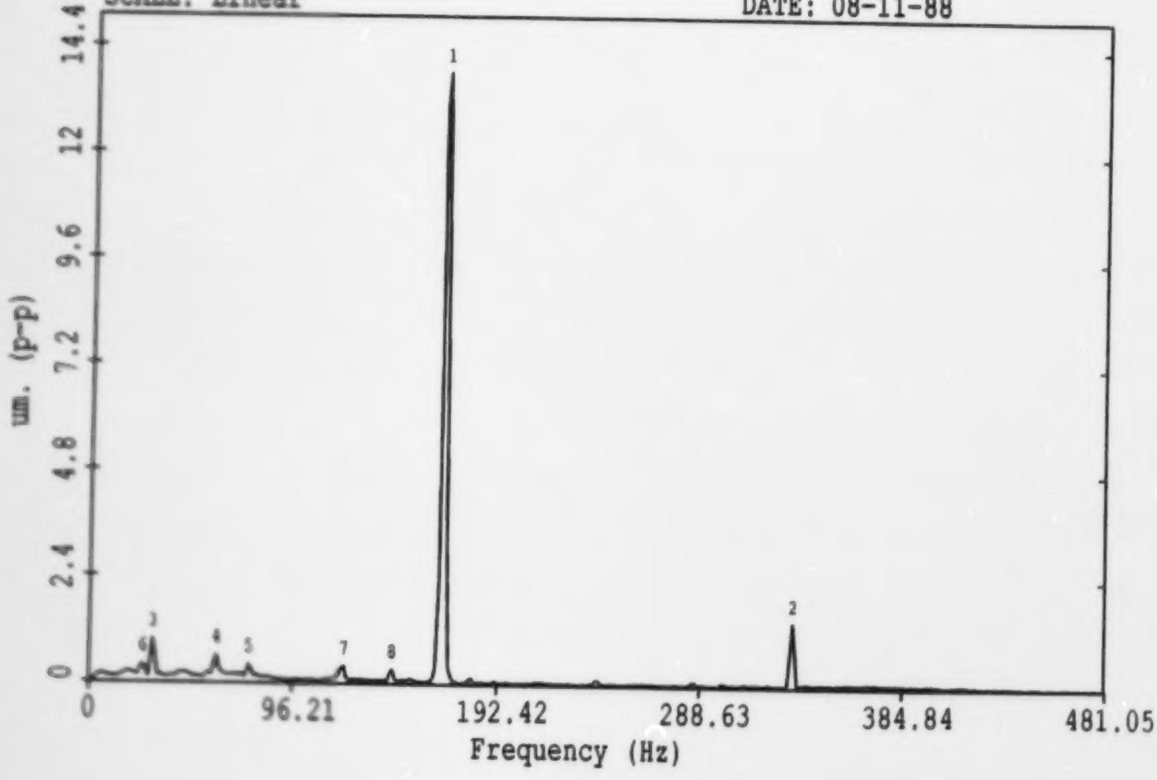


FIGURE F46

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #3 Shaft Displacement Horiz.
PROCESS CONDITION : Load 6.0 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 167.2 | 13.82 |
| 2 | 333.1 | 1.46 |
| 3 | 30.1 | 0.99 |
| 4 | 60.1 | 0.64 |
| 5 | 75.8 | 0.43 |
| 6 | 25.3 | 0.42 |
| 7 | 120.3 | 0.39 |
| 8 | 143.1 | 0.33 |



SCALE: Linear

DATE: 08-11-88

FIGURE F47

# Darlington NGS 'A' Emergency Power Generator #1

SIGNAL : Bearing #3 Shaft Displacement Horiz.
PROCESS CONDITION : Load 6.9 MW

| PEAK NO. | FREQUENCY | AMPLITUDE |
|---|---|---|
| 1 | 170.8 | 14.51 |
| 2 | 342.8 | 1.52 |
| 3 | 30.1 | 0.98 |
| 4 | 60.1 | 0.85 |
| 5 | 75.8 | 0.52 |
| 6 | 25.3 | 0.40 |
| 7 | 120.3 | 0.40 |

SCALE: Linear

DATE: 08-11-88

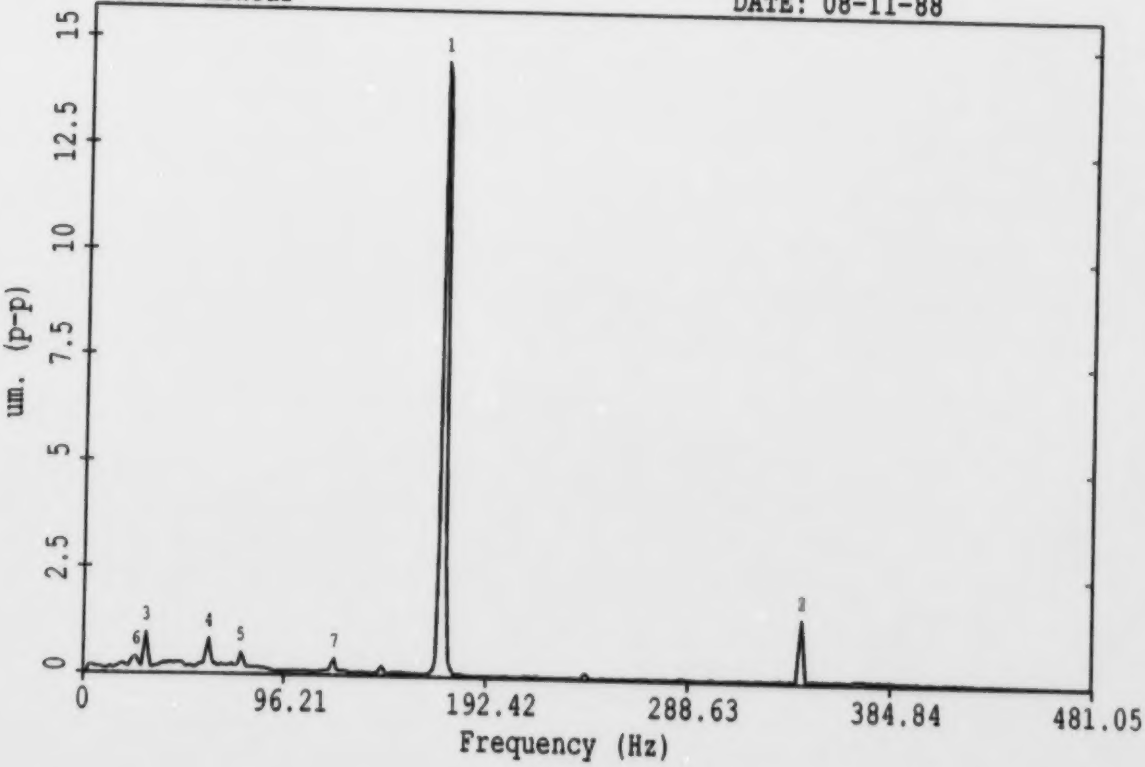


FIGURE F48

# APPENDIX G

# BODE PLOTS OF VIBRATION DURING COLD START RUNUP

# TABLE G1
## DARLINGTON NGS 'A' EMERGENCY POWER GENERATOR #1
## FIGURE NUMBERS FOR BODE PLOTS OF VIBRATION DURING COLD START RUNUP

| Measurement | | Figure No of Bode Plot |
|---|---|---|
| AC Generator Outboard Bearing Casing Velocity | - Vertical Direction | G1 |
| | - Horizontal Direction | G2 |
| AC Generator Inboard Bearing Casing Velocity | - Vertical Direction | G3 |
| | - Horizontal Direction | G4 |
| Power Turbine Bearing No 5 Casing Velocity | - Vertical Direction | G5 |
| | - Horizontal Direction | G6 |
| | - Axial Direction | G7 |
| AC Generator Outboard Bearing Shaft Displacement | - Vertical Direction | G8 |
| | - Horizontal Direction | G9 |
| AC Generator Inboard Bearing Shaft Displacement | - Vertical Direction | G10 |
| | - Horizontal Direction | G11 |
| Power Turbine Bearing No 4 Shaft Displacement | - Vertical Direction | G12 |
| | - Horizontal Direction | G13 |
| Power Turbine Bearing No 5 Shaft Displacement | - Vertical Direction | G14 |
| | - Horizontal Direction | G15 |
| Gas Producer Bearing No 1 Shaft Displacement | - Vertical Direction | G16 |
| | - Horizontal Direction | G17 |
| Gas Producer Bearing No 2 Shaft Displacement | - Vertical Direction | G18 |
| | - Horizontal Direction | G19 |
| Gas Producer Bearing No 3 Shaft Displacement | - Vertical Direction | G20 |
| | - Horizontal Direction | G21 |

DARLINGTON NGS A EMERGENCY POWER GENERATOR #1
AC GENERATOR COLD RUNUP OB BRG CASING VELOCITY VERT.

BODE PLOT Order : 1.00
Date : 7-NOV-88

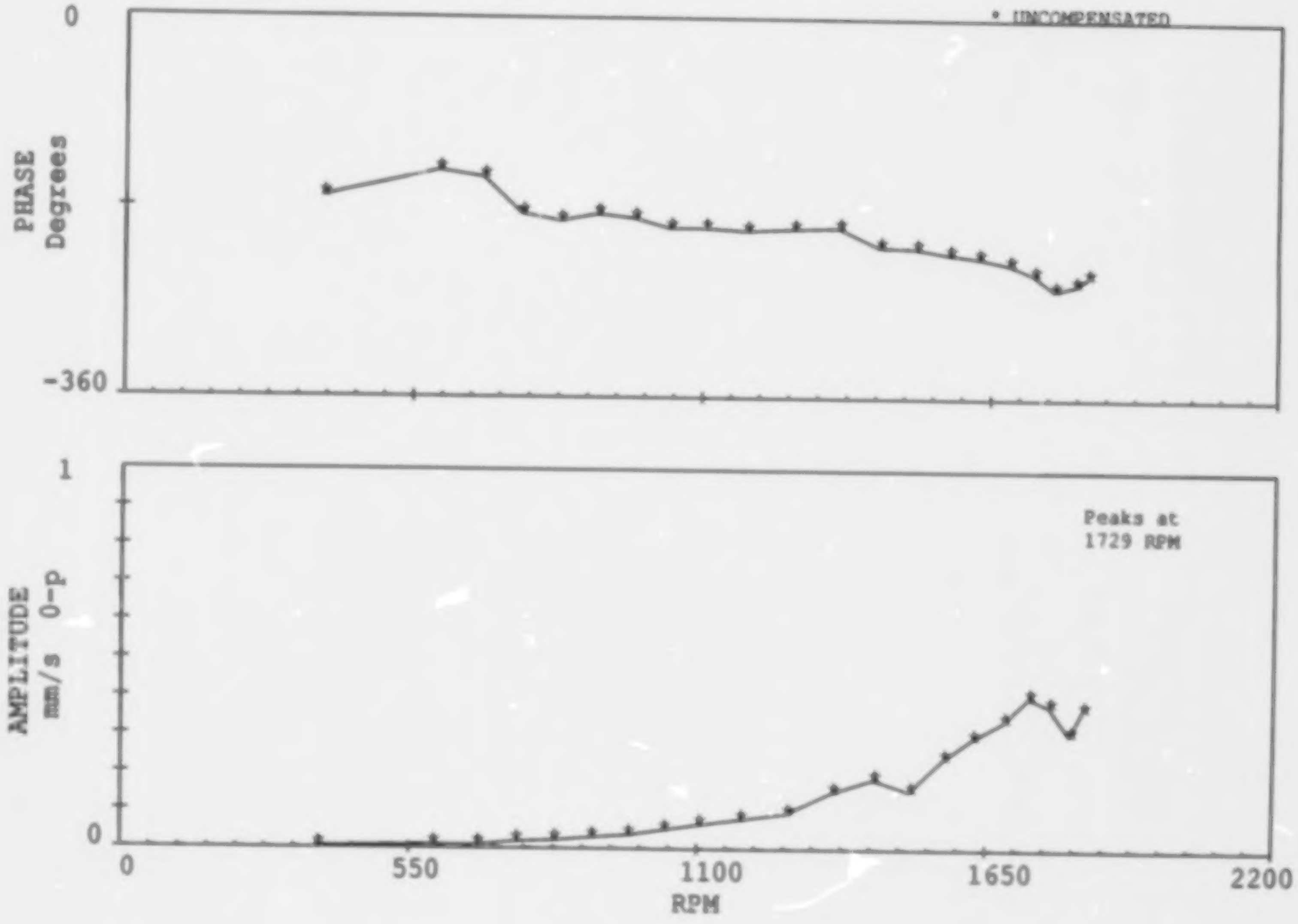


FIGURE G1

90-338

DARLINGTON NGS A EMERGENCY POWER GENERATOR #1
AC GENERATOR COLD RUNUP OB BRG CASING VELOCITY HOR.

BODE PLOT Order : 1.00
Date : 7-NOV-88

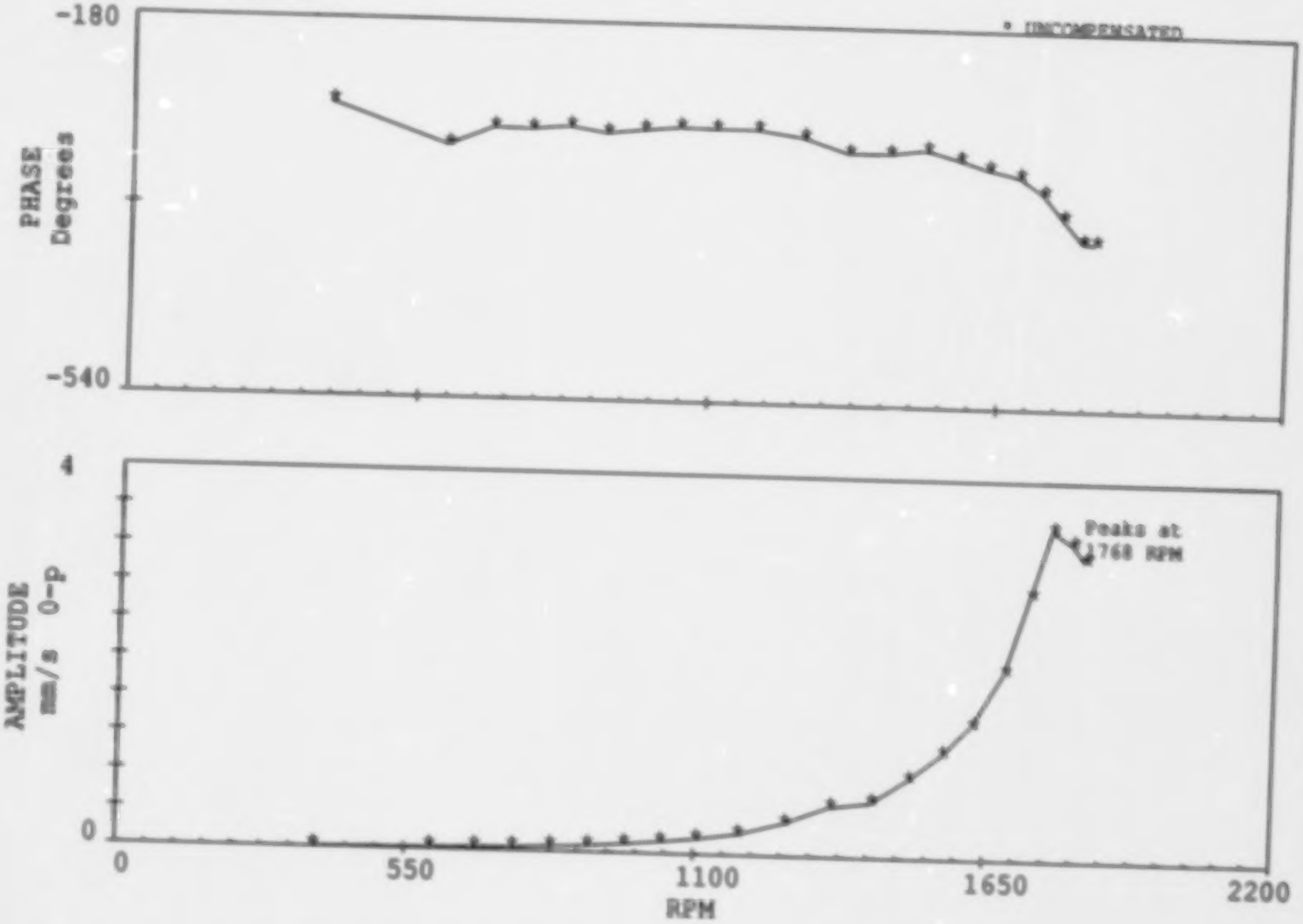


FIGURE G2

DARLINGTON NGS A EMERGENCY POWER GENERATOR #1
AC GENERATOR COLD RUNUP IB BRG CASING VELOCITY VERT.

BODE PLOT Order : 1.00
Date : 7-NOV-88

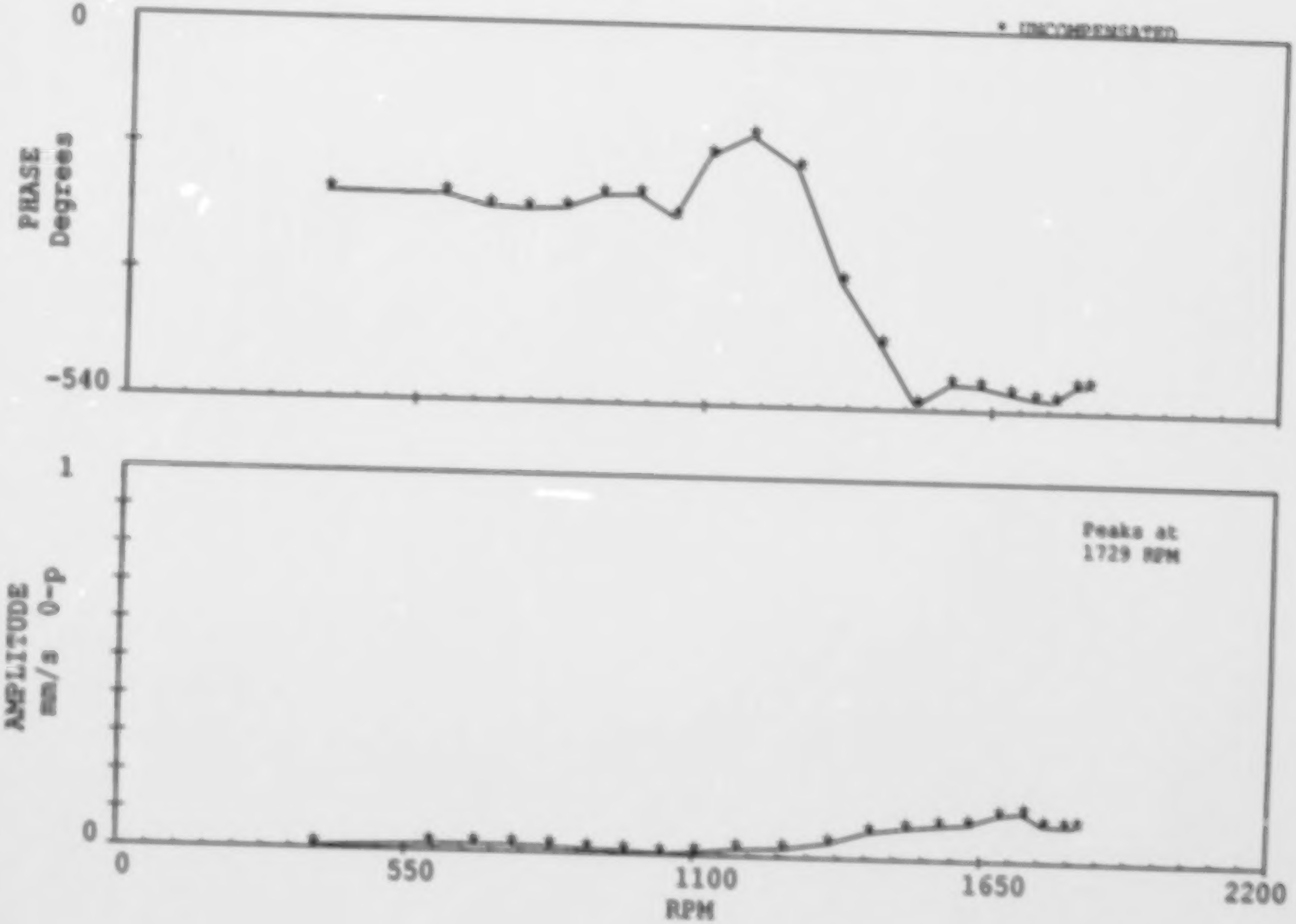


FIGURE G3

DARLINGTON NGS A EMERGENCY POWER GENERATOR #1
AC GENERATOR COLD RUNUP IB BRG CASING VELOCITY HOR.

BODE PLOT Order : 1.00
Date : 7-NOV-88

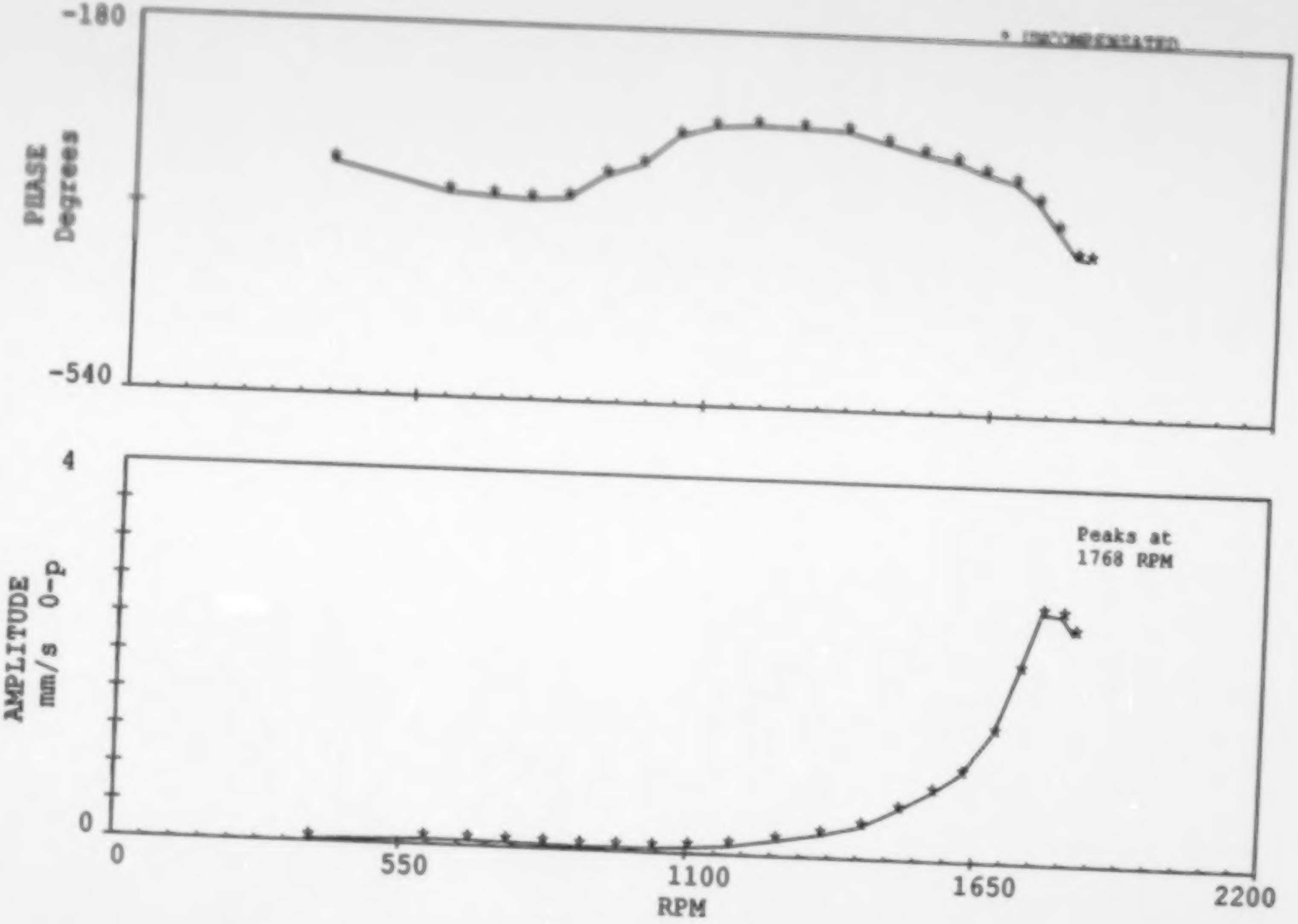


FIGURE G4

90-338

DARLINGTON NGS A EMERGENCY POWER GENERATOR #1
POWER TURBINE COLD RUNUP BRG #5 CASING VELOCITY VERT.

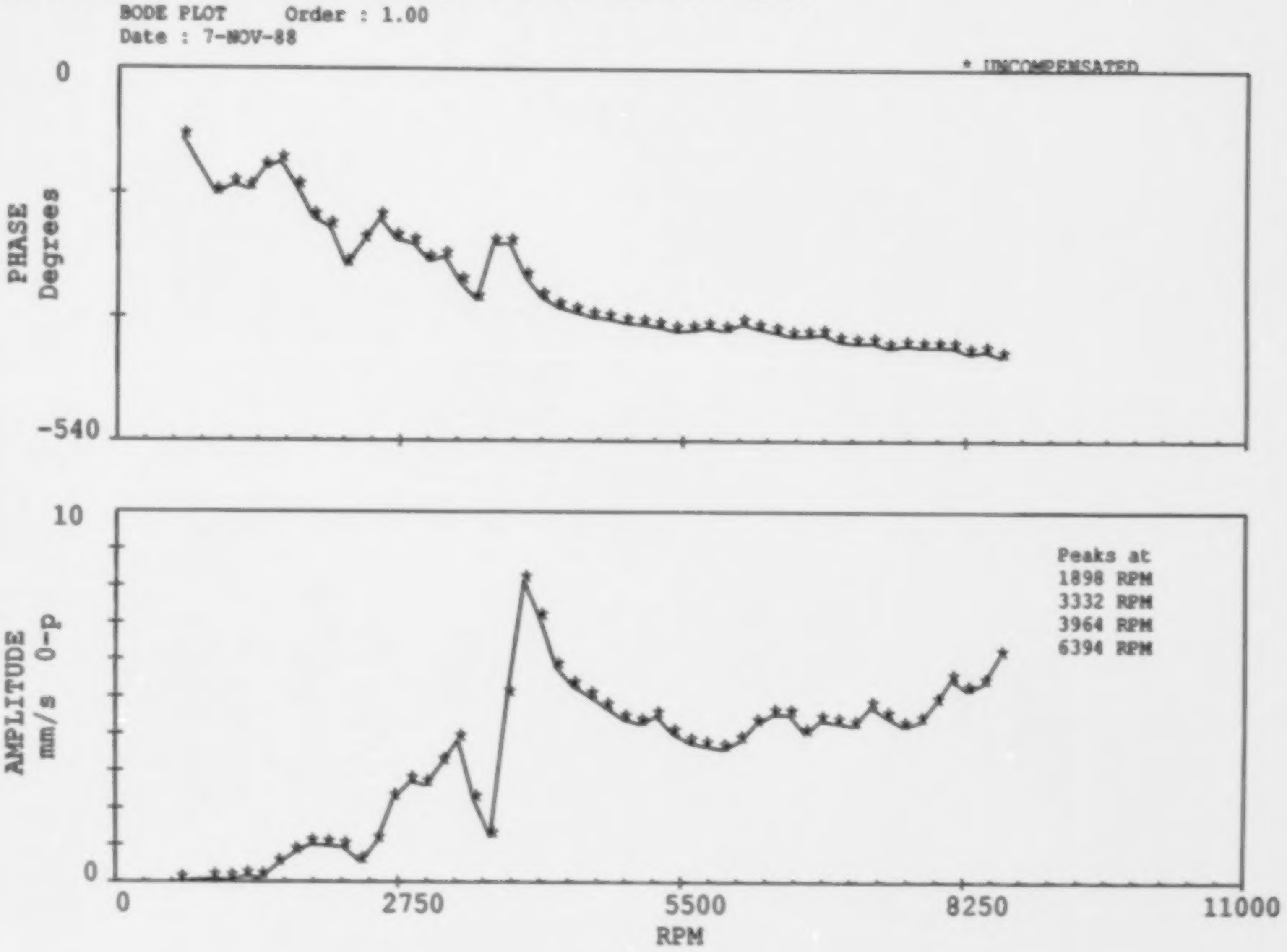


FIGURE G5

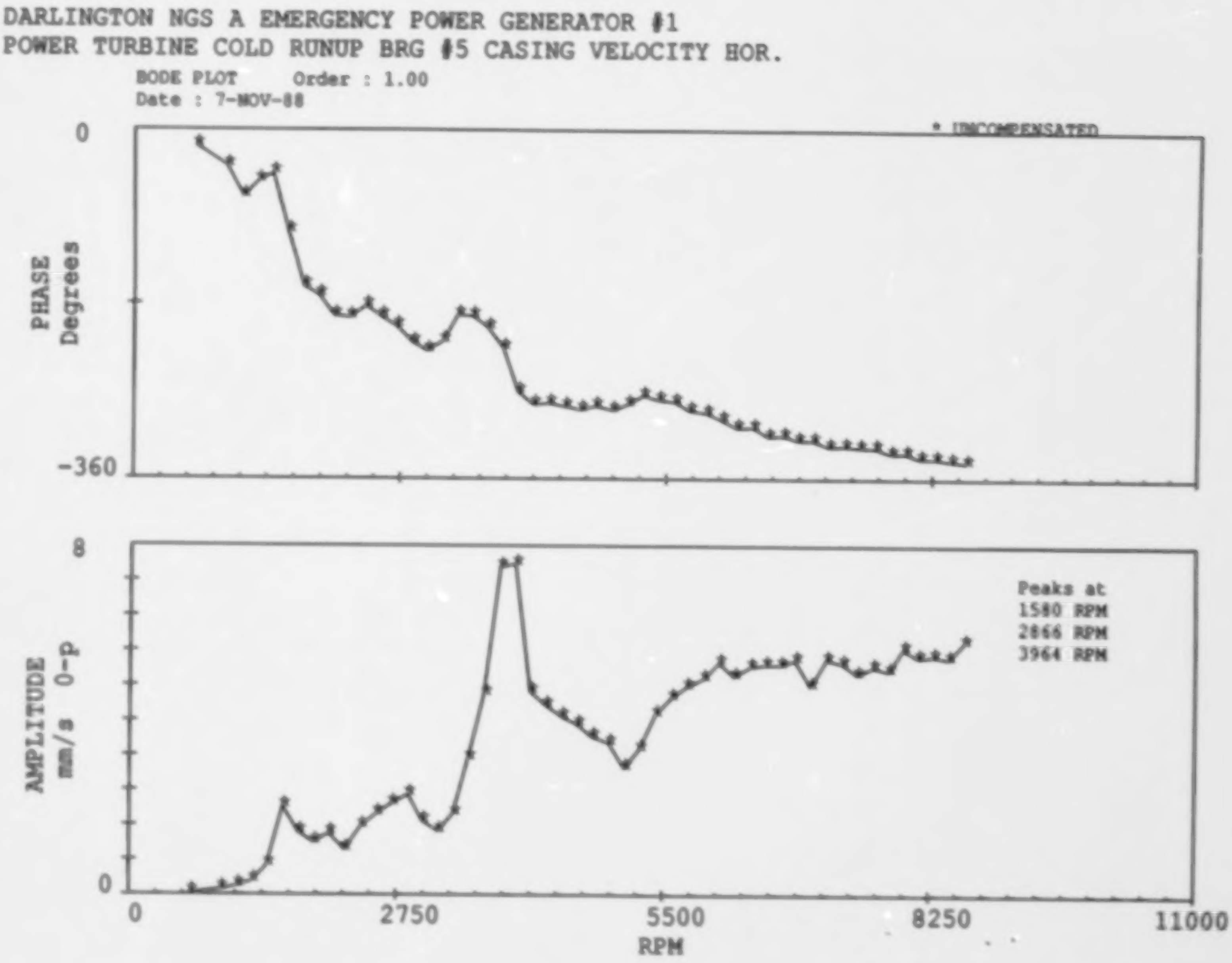

DARLINGTON NGS A EMERGENCY POWER GENERATOR #1
POWER TURBINE COLD RUNUP BRG #5 CASING VELOCITY HOR.
BODE PLOT Order : 1.00
Date : 7-NOV-88
* UNCOMPENSATED
PHASE
Degrees
0
-360
AMPLITUDE
mm/s 0-p
8
0
Peaks at
1580 RPM
2866 RPM
3964 RPM
0
2750
5500
8250
11000
RPM

FIGURE G6

DARLINGTON NGS A EMERGENCY POWER GENERATOR #1
POWER TURBINE COLD RUNUP BRG #5 CASING VELOCITY AXIAL

BODE PLOT Order : 1.00
Date : 7-NOV-88

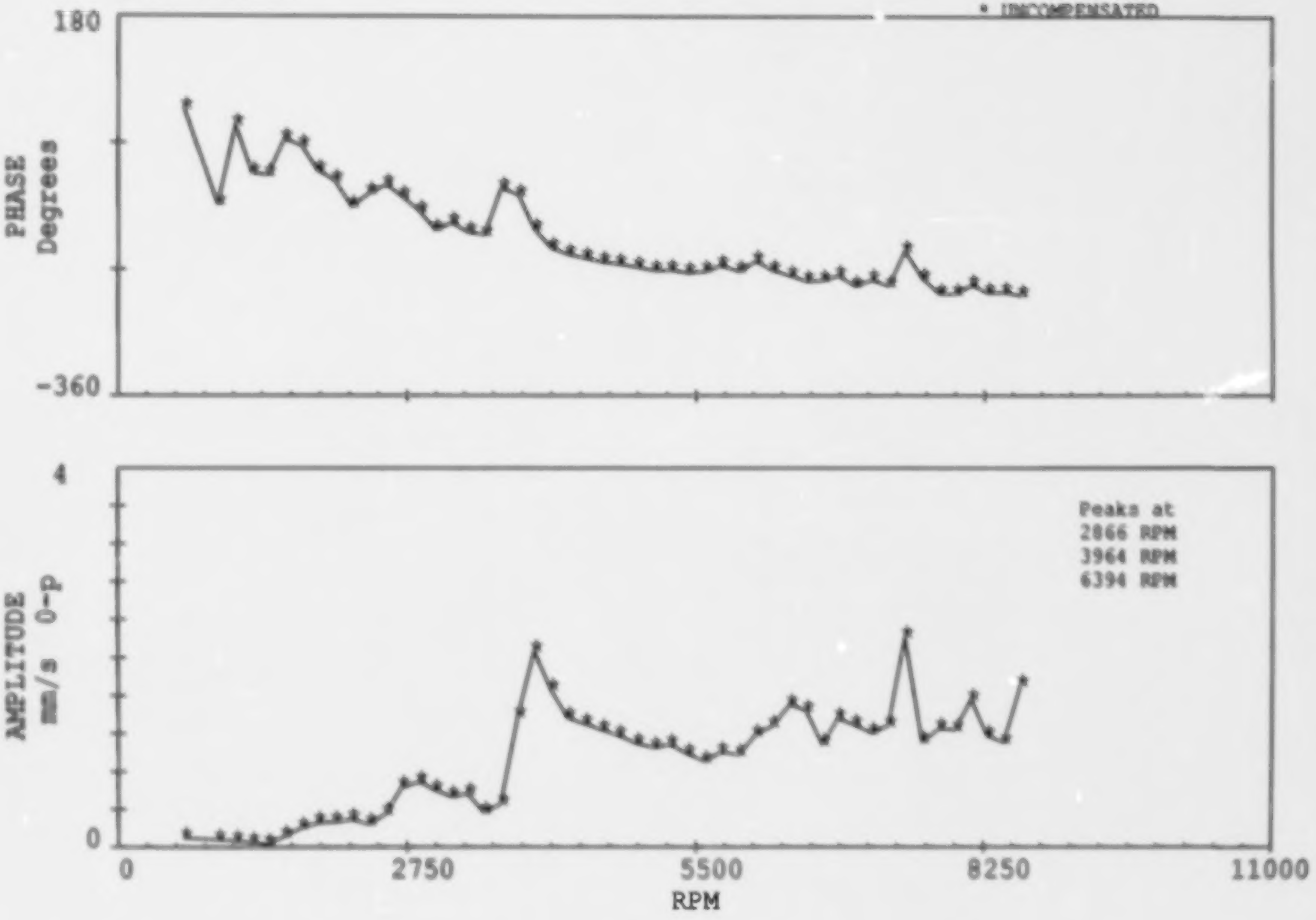


FIGURE G7

DARLINGTON NGS A EMERGENCY POWER GENERATOR #1
AC GENERATOR COLD RUNUP SHAFT DISPLACEMENT OB BRG VERT

BODE PLOT     Order : 1.00
Date : 7-NOV-88

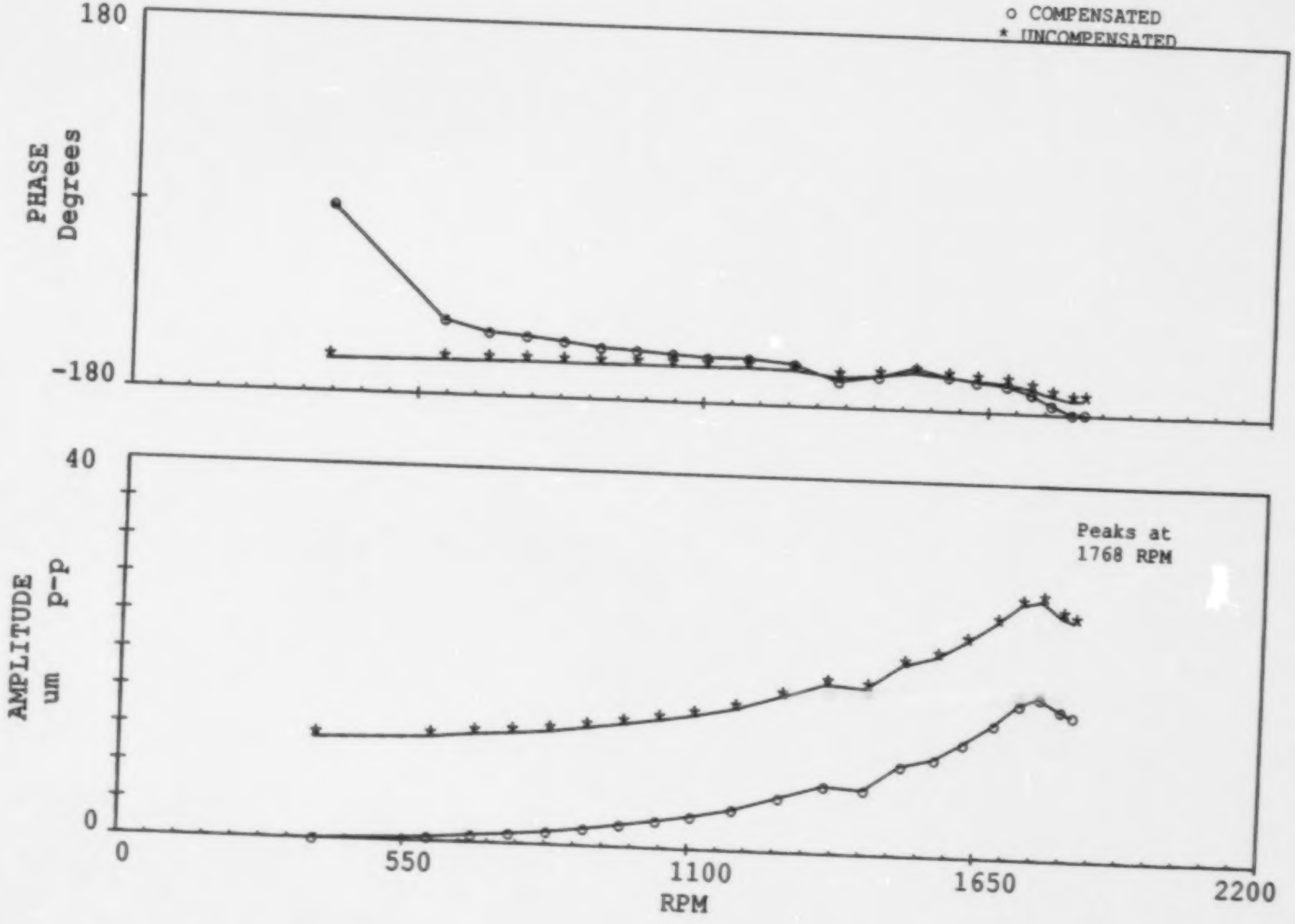


FIGURE G8

90-338

DARLINGTON NGS A EMERGENCY POWER GENERATOR #1
AC GENERATOR COLD RUNUP SHAFT DISPLACEMENT OB BRG HOR.

BODE PLOT Order : 1.00
Date : 7-NOV-88

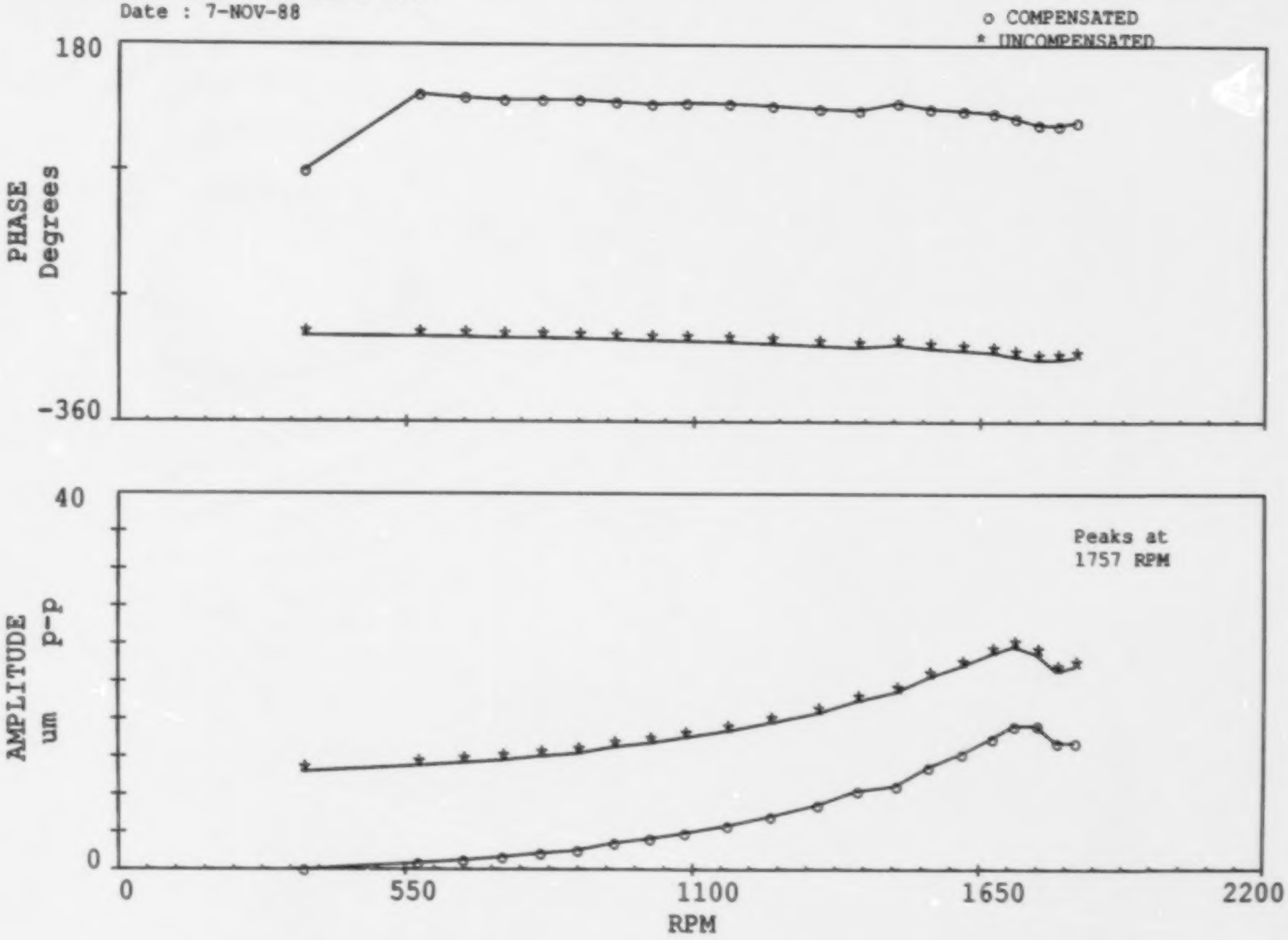


FIGURE G9

DARLINGTON NGS A EMERGENCY POWER GENERATOR #1
AC GENERATOR COLD RUNUP SHAFT DISPLACEMENT IB BRG VERT

BODE PLOT    Order : 1.00
Date : 7-NOV-88

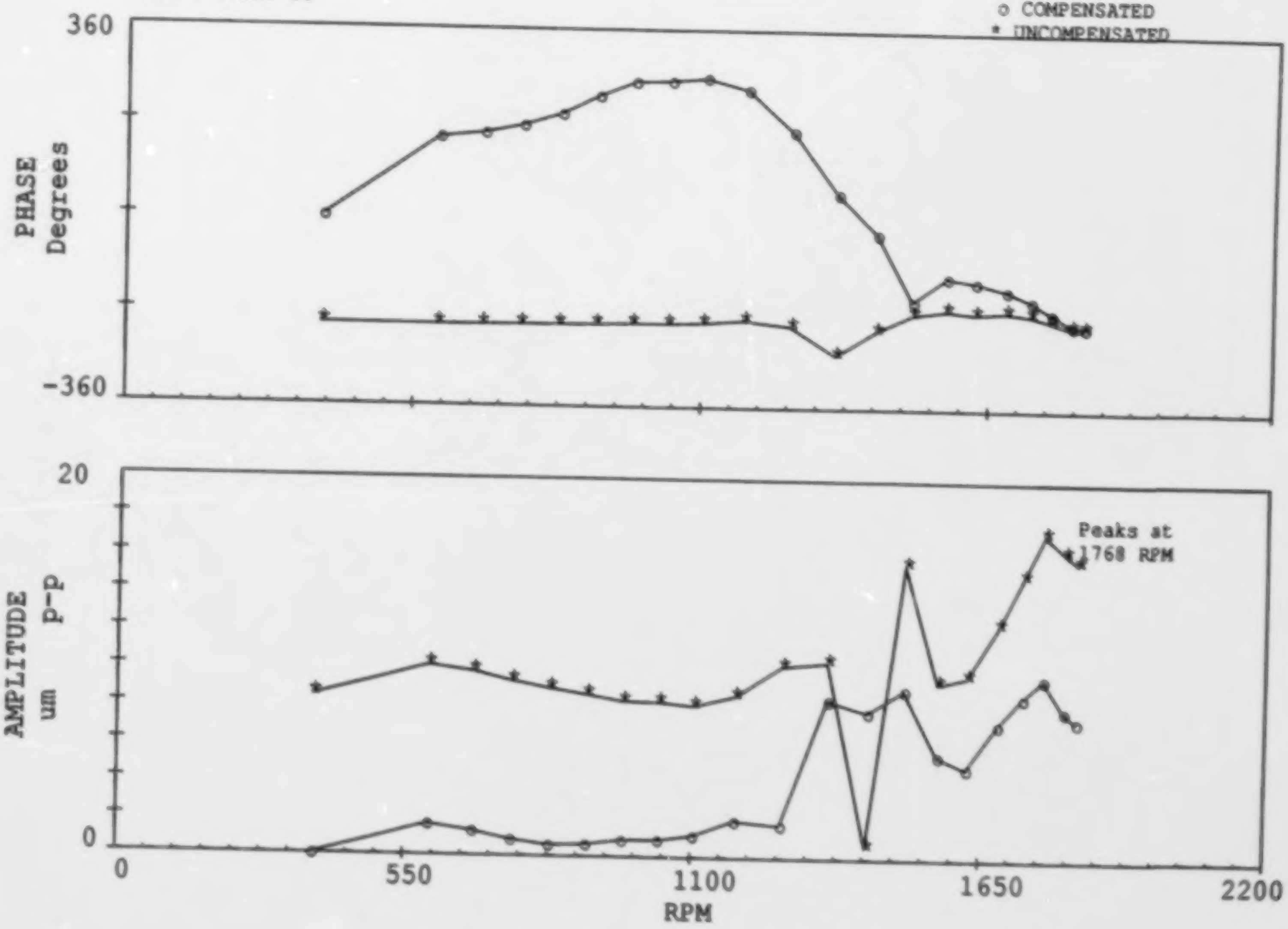


FIGURE G10

DARLINGTON NGS A EMERGENCY POWER GENERATOR #1
AC GENERATOR COLD RUNUP SHAFT DISPLACEMENT IB BRG HOR.

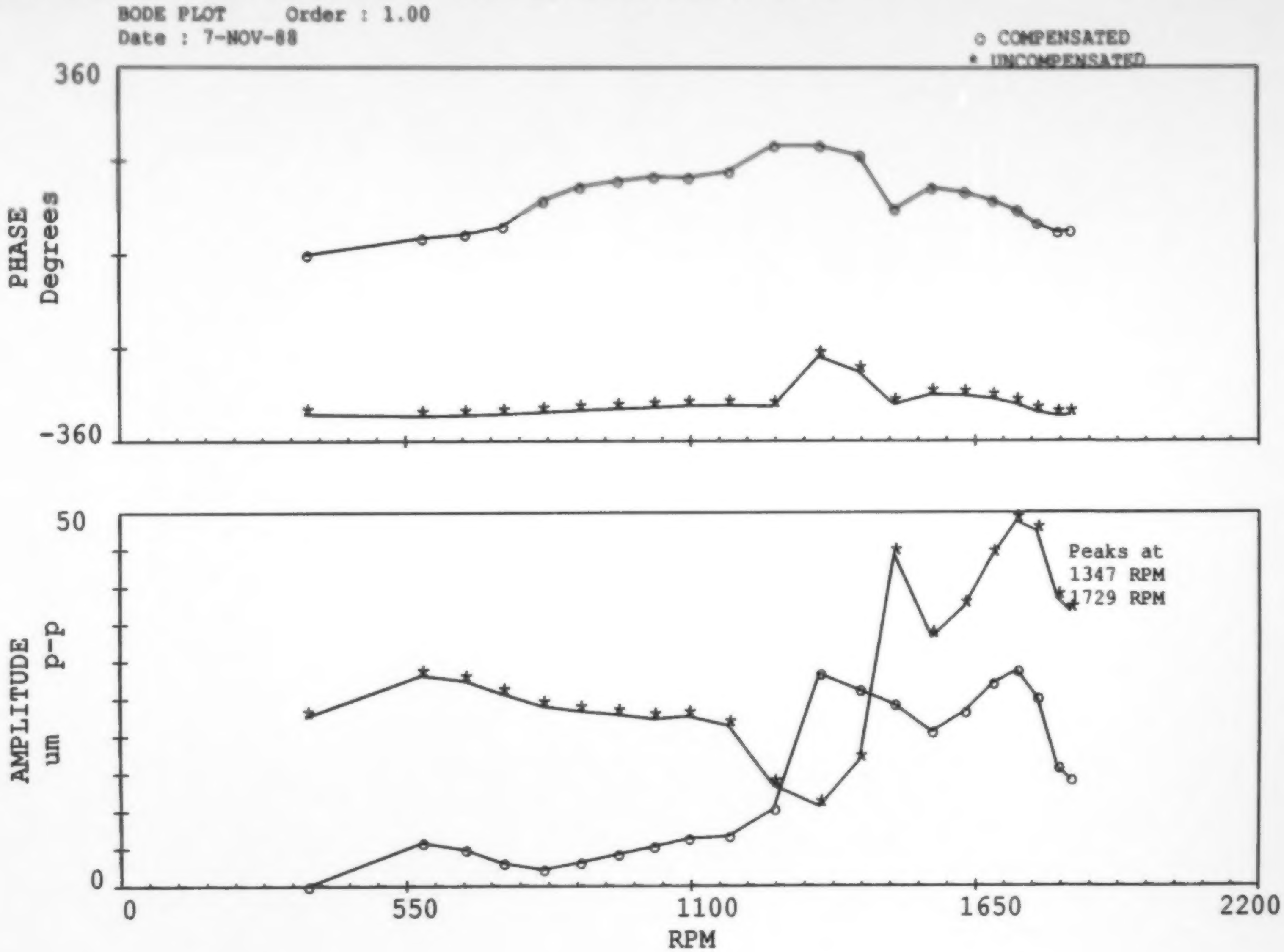


FIGURE G11

DARLINGTON NGS A EMERGENCY POWER GENERATOR #1
POWER TURBINE COLD RUNUP BRG #4 SHAFT DISPLACEMENT VERT

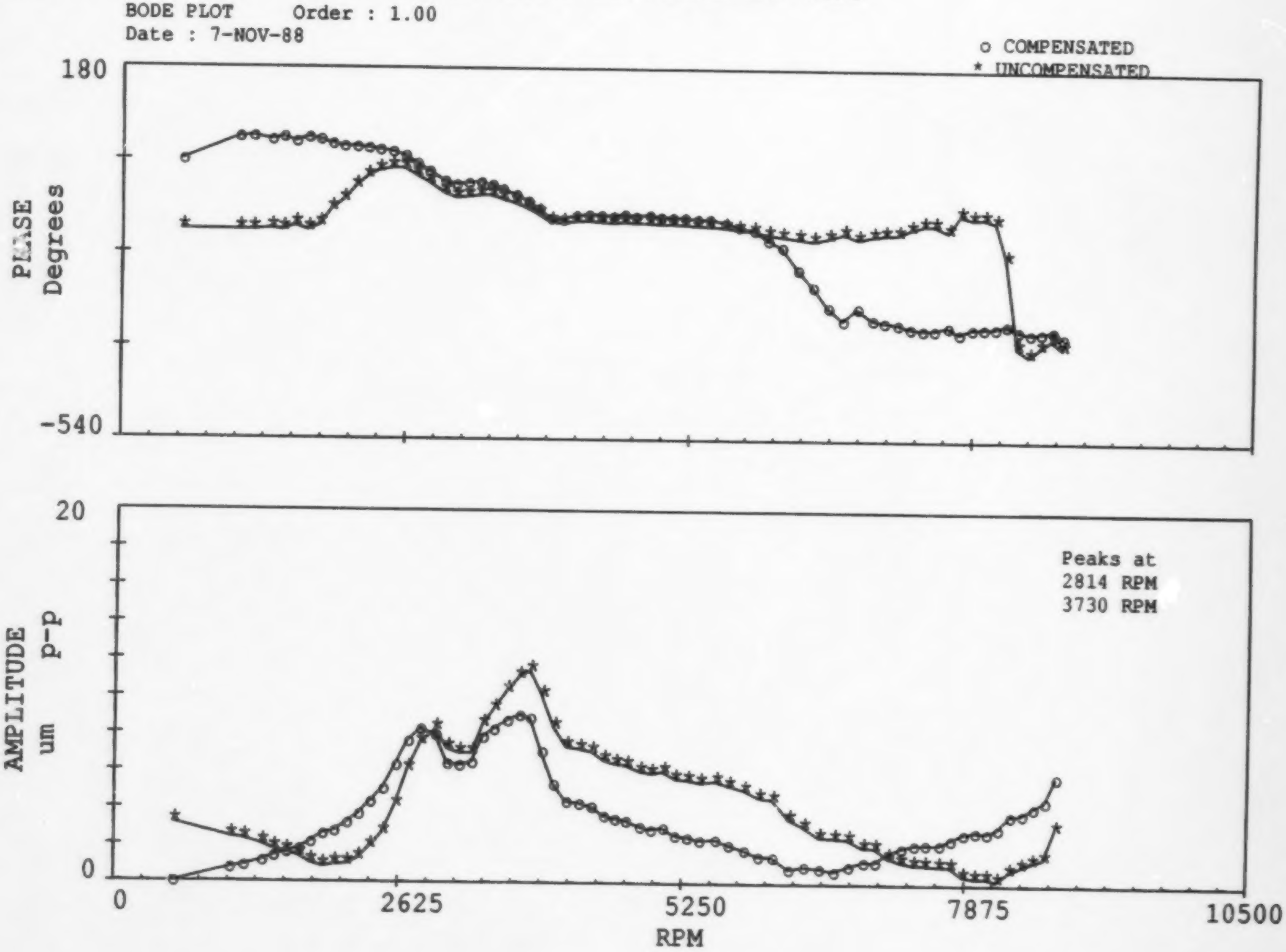


FIGURE G12

DARLINGTON NGS A EMERGENCY POWER GENERATOR #1
POWER TURBINE COLD RUNUP BRG #4 SHAFT DISPLACEMENT HOR.

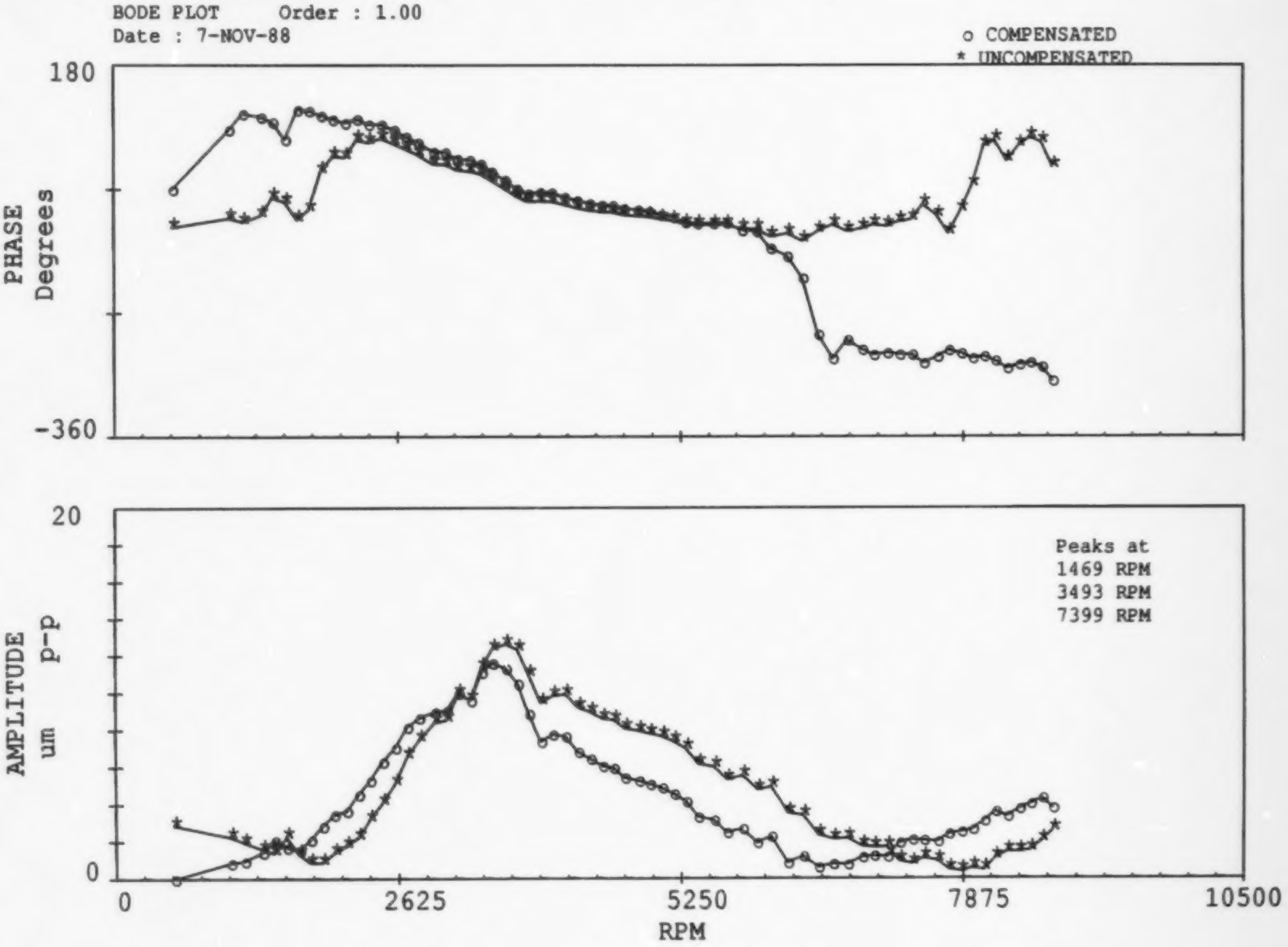


FIGURE G13

DARLINGTON NGS A EMERGENCY POWER GENERATOR #1
POWER TURBINE COLD RUNUP BRG #5 SHAFT DISPLACEMENT VERT

BODE PLOT Order : 1.00
Date : 7-NOV-88

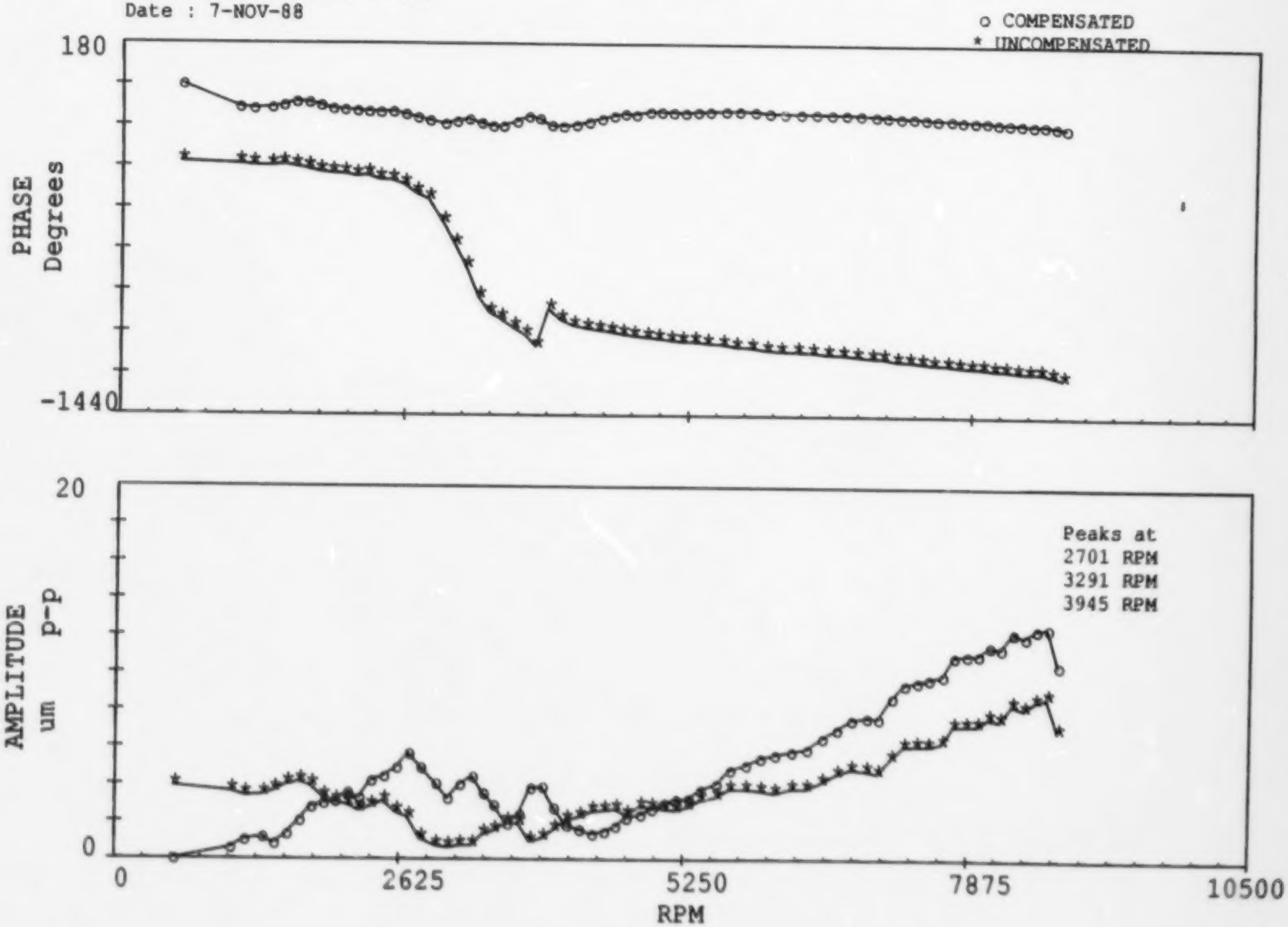


FIGURE G14

DARLINGTON NGS A EMERGENCY POWER GENERATOR #1
POWER TURBINE COLD RUNUP BRG #5 SHAFT DISPLACEMENT HOR.

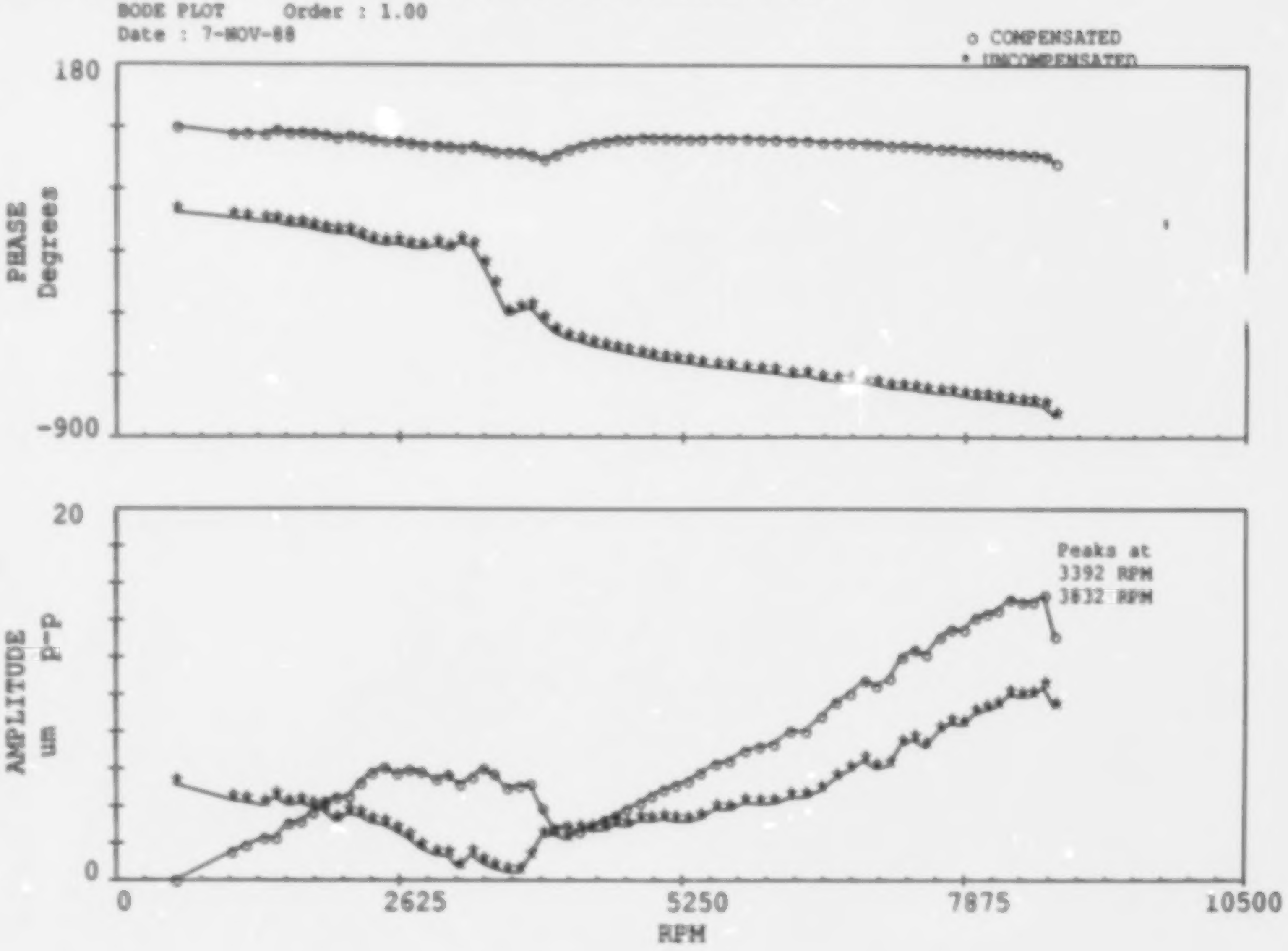


FIGURE G15

90-338

DARLINGTON NGS A EMERGENCY POWER GENERATOR #1
GAS GENERATOR COLD RUNUP BRG #1 SHAFT DISPLACEMENT VERT

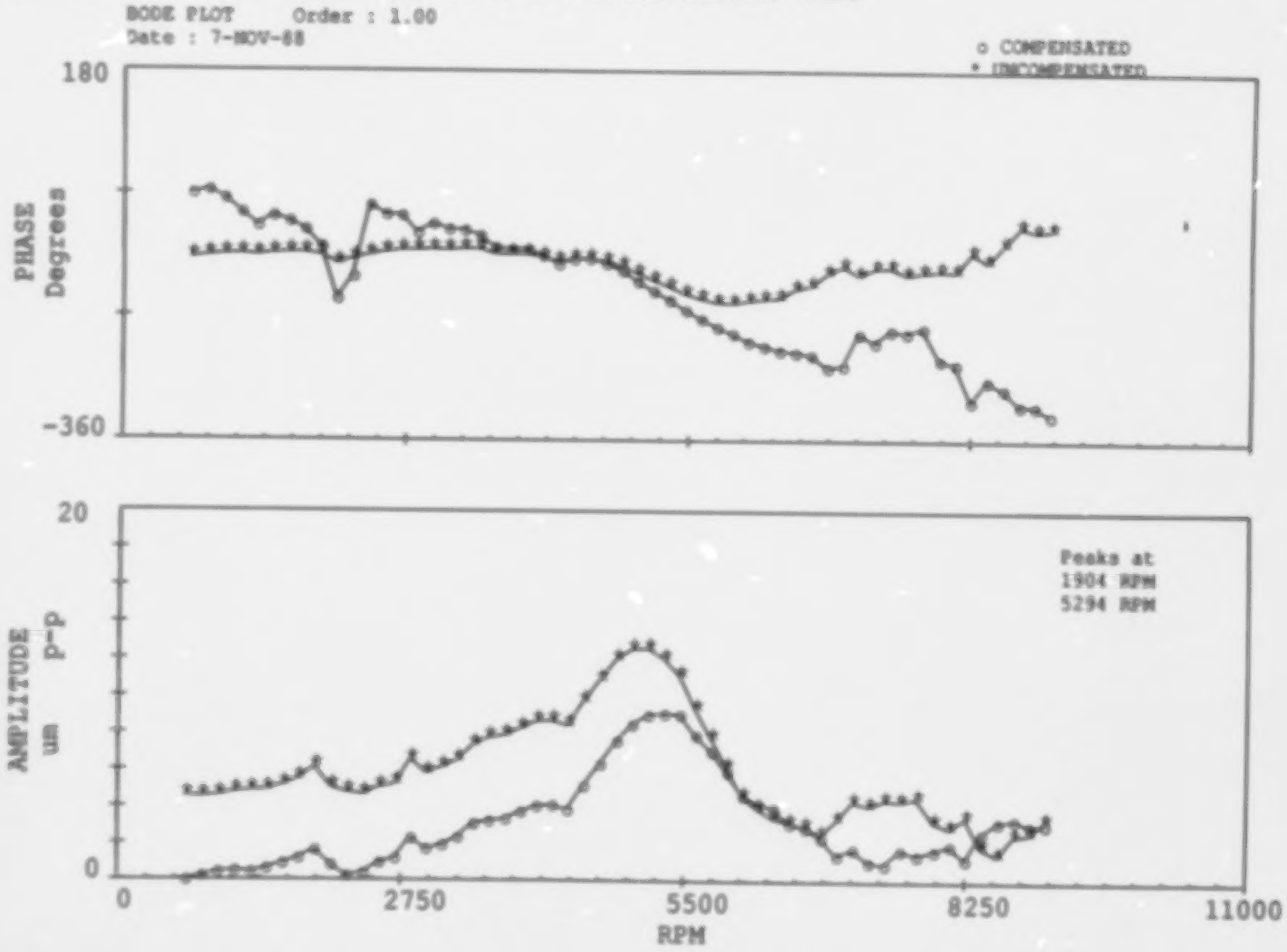


FIGURE G16

DARLINGTON NGS A EMERGENCY POWER GENERATOR #1
GAS GENERATOR COLD RUNUP BRG #1 SHAFT DISPLACEMENT HOR.

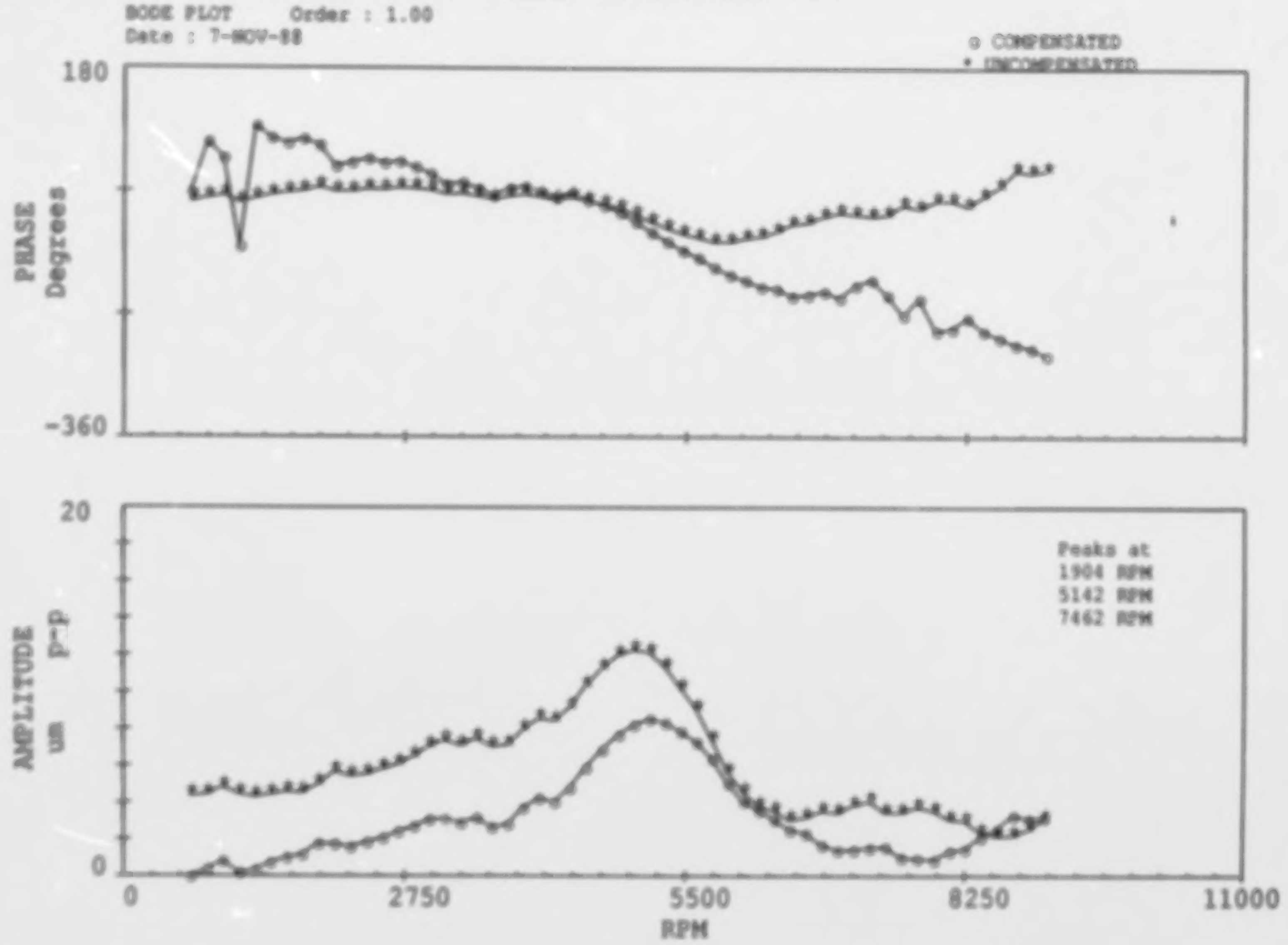


FIGURE G17

DARLINGTON NGS A EMERGENCY POWER GENERATOR #1
GAS GENERATOR COLD RUNUP BRG #2 SHAFT DISPLACEMENT VERT

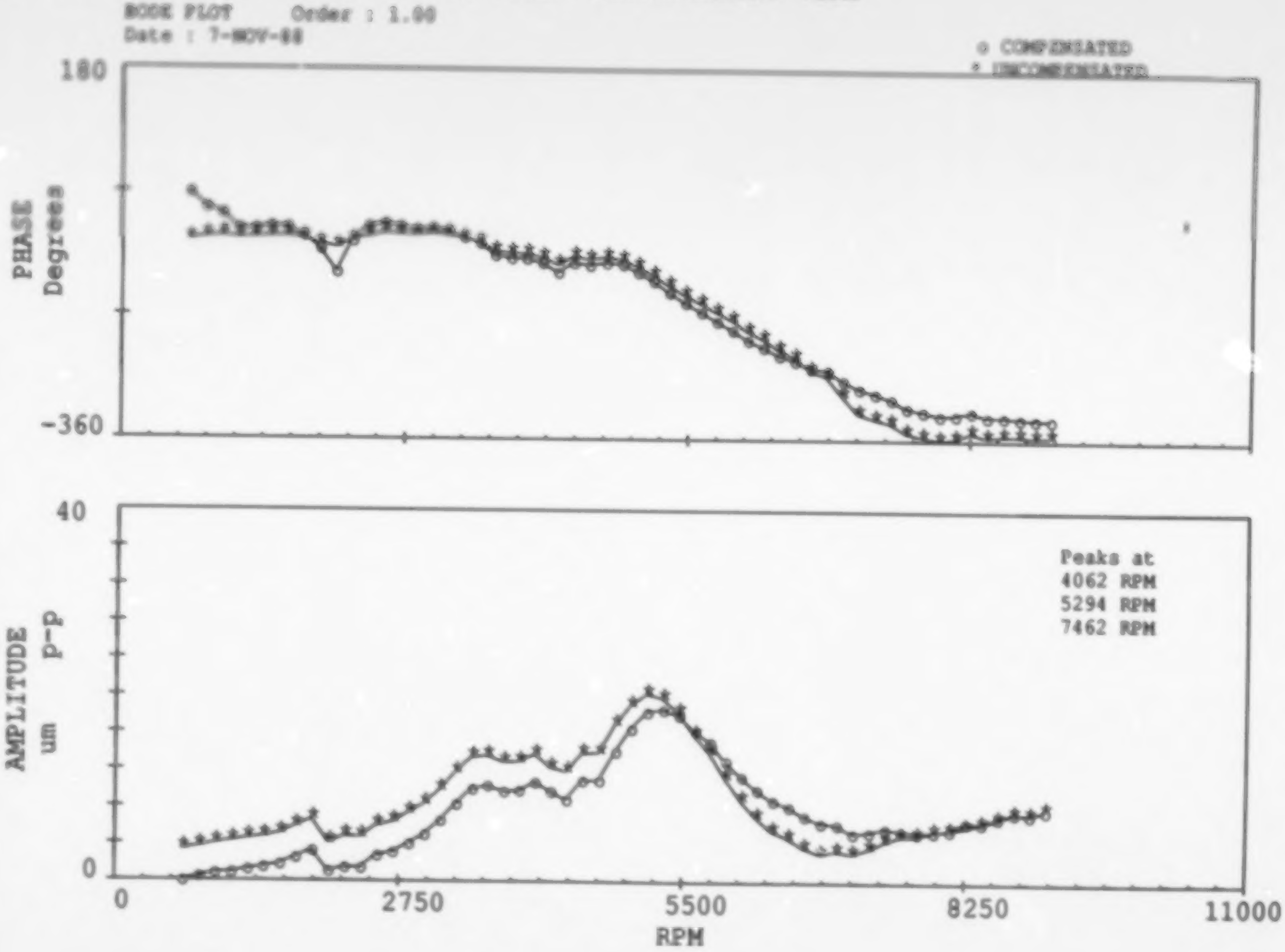


FIGURE G18

DARLINGTON NGS A EMERGENCY POWER GENERATOR #1
GAS GENERATOR COLD RUNUP BRG #2 SHAFT DISPLACEMENT HOR.

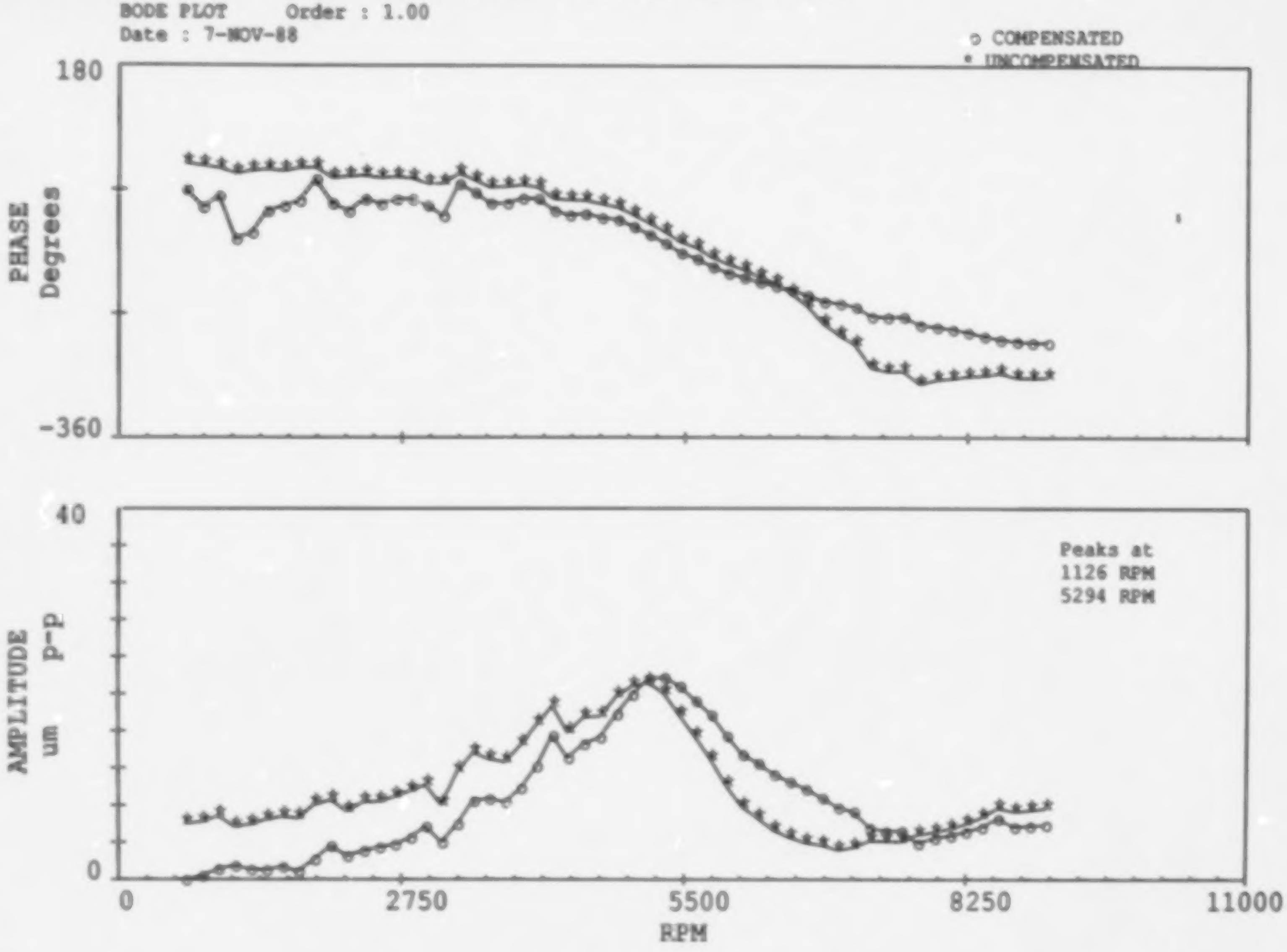


FIGURE G19

DARLINGTON NGS A EMERGENCY POWER GENERATOR #1
GAS GENERATOR COLD RUNUP BRG #3 SHAFT DISPLACEMENT VERT

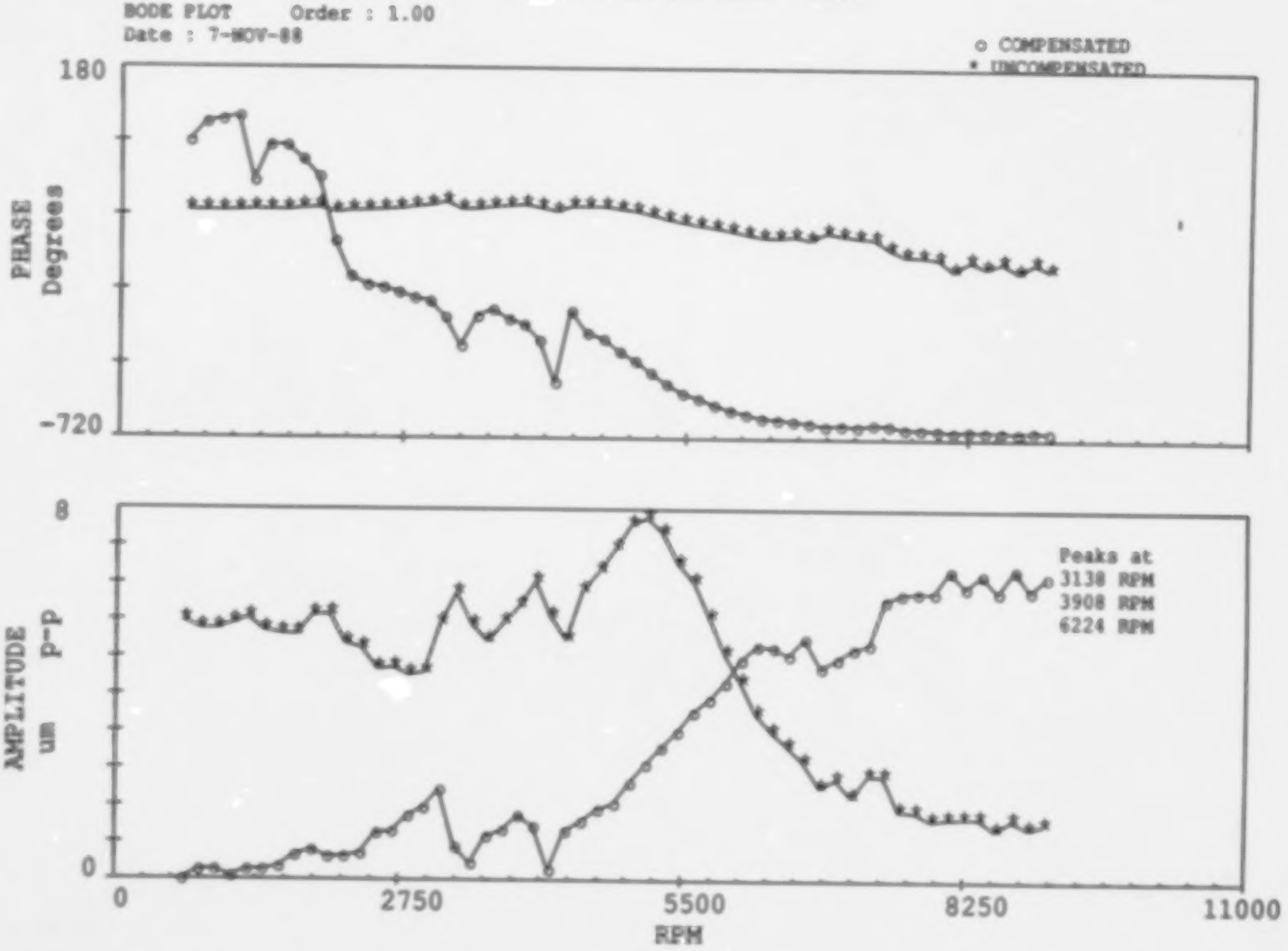


FIGURE G20

DARLINGTON NGS A EMERGENCY POWER GENERATOR #1
GAS GENERATOR COLD RUNUP BRG #3 SHAFT DISPLACEMENT HOR.

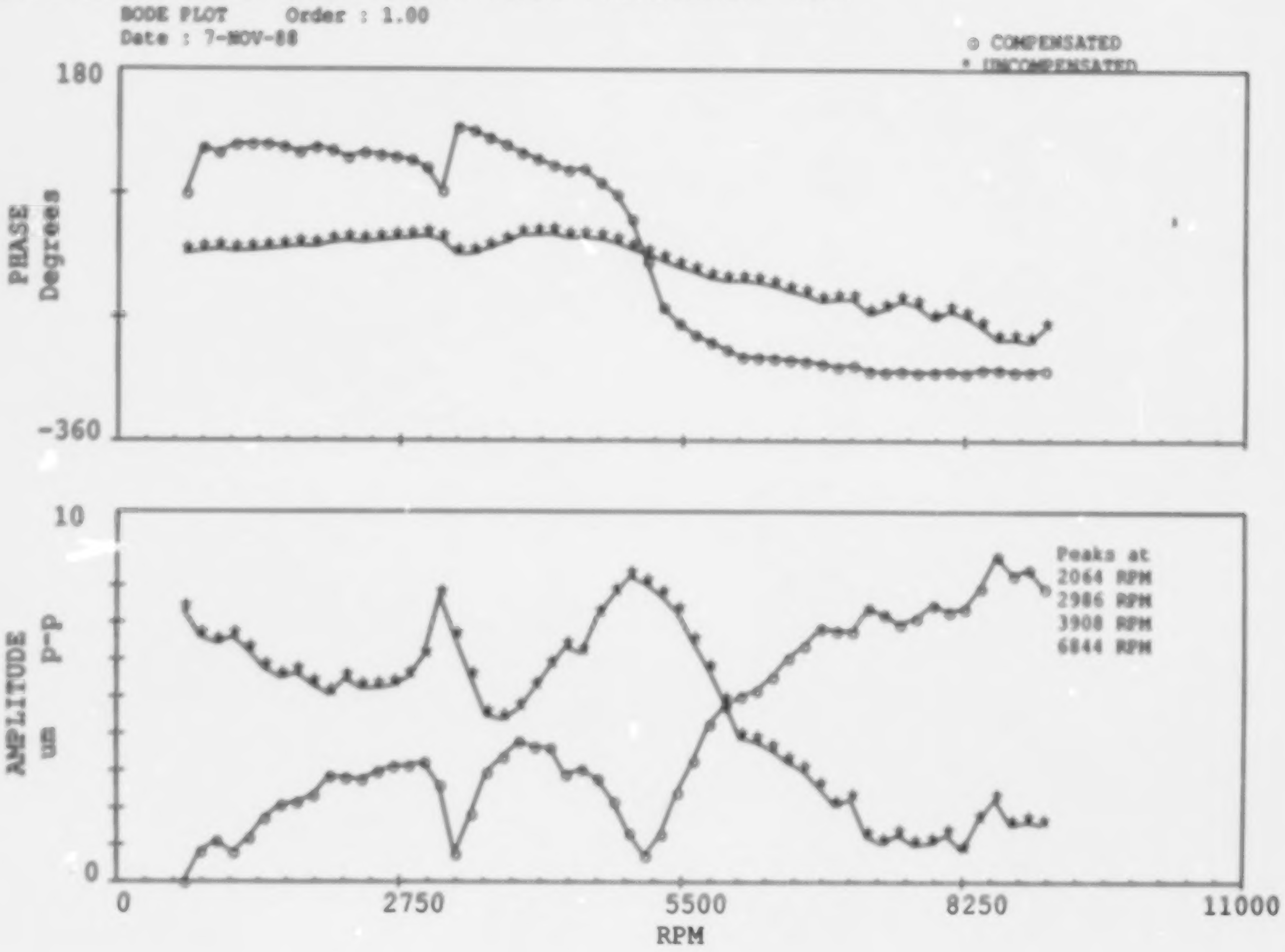


FIGURE G21

# APPENDIX H

## BODE PLOTS OF VIBRATION DURING HOT RUNDOWN

### TABLE H1

### DARLINGTON NGS 'A' EMERGENCY POWER GENERATOR #1

### FIGURE NUMBERS FOR BODE PLOTS OF VIBRATION DURING HOT RUNDOWN

| Measurement | | Figure No of Bode Plot |
|---|---|---|
| AC Generator Outboard Bearing Casing Velocity | - Vertical Direction | H1 |
| | - Horizontal Direction | H2 |
| AC Generator Inboard Bearing Casing Velocity | - Vertical Direction | H3 |
| | - Horizontal Direction | H4 |
| Power Turbine Bearing No 5 Casing Velocity | - Vertical Direction | H5 |
| | - Horizontal Direction | H6 |
| | - Axial Direction | H7 |
| AC Generator Outboard Bearing Shaft Displacement | - Vertical Direction | H8 |
| | - Horizontal Direction | H9 |
| AC Generator Inboard Bearing Shaft Displacement | - Vertical Direction | H10 |
| | - Horizontal Direction | H11 |
| Power Turbine Bearing No 4 Shaft Displacement | - Vertical Direction | H12 |
| | - Horizontal Direction | H13 |
| Power Turbine Bearing No 5 Shaft Displacement | - Vertical Direction | H14 |
| | - Horizontal Direction | H15 |
| Gas Producer Bearing No 1 Shaft Displacement | - Vertical Direction | H16 |
| | - Horizontal Direction | H17 |
| Gas Producer Bearing No 2 Shaft Displacement | - Vertical Direction | H18 |
| | - Horizontal Direction | H19 |
| Gas Producer Bearing No 3 Shaft Displacement | - Vertical Direction | H20 |
| | - Horizontal Direction | H21 |

DARLINGTON NGS A EMERGENCY POWER GENERATOR #1
AC GENERATOR HOT RUNDOWN OB BRG CASING VELOCITY VERT.

BODE PLOT Order : 1.00
Date : 7-NOV-88

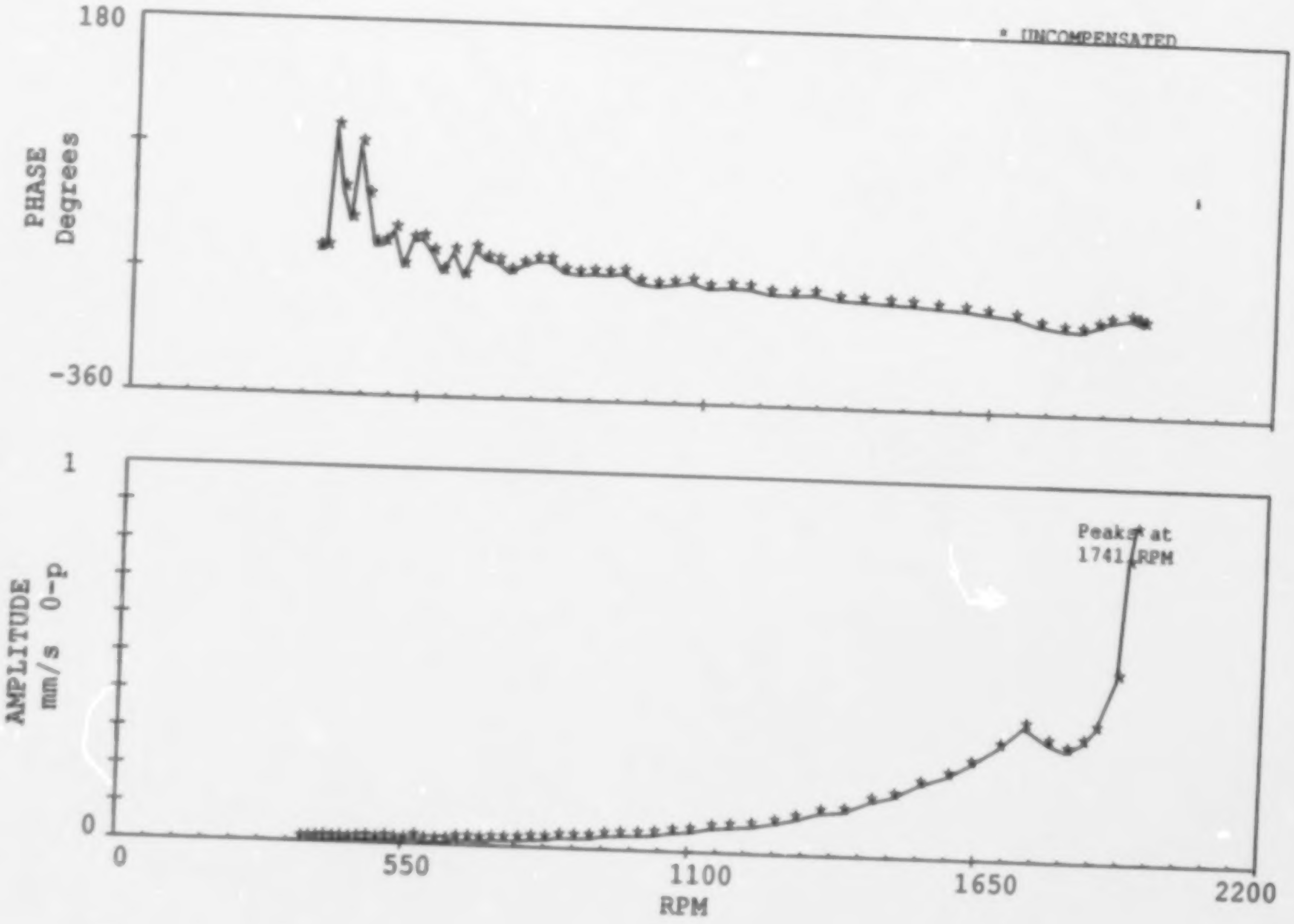


FIGURE H1

DARLINGTON NGS A EMERGENCY POWER GENERATOR #1
AC GENERATOR HOT RUNDOWN OB BRG CASING VELOCITY HOR.

BODE PLOT Order : 1.00
Date : 7-NOV-88

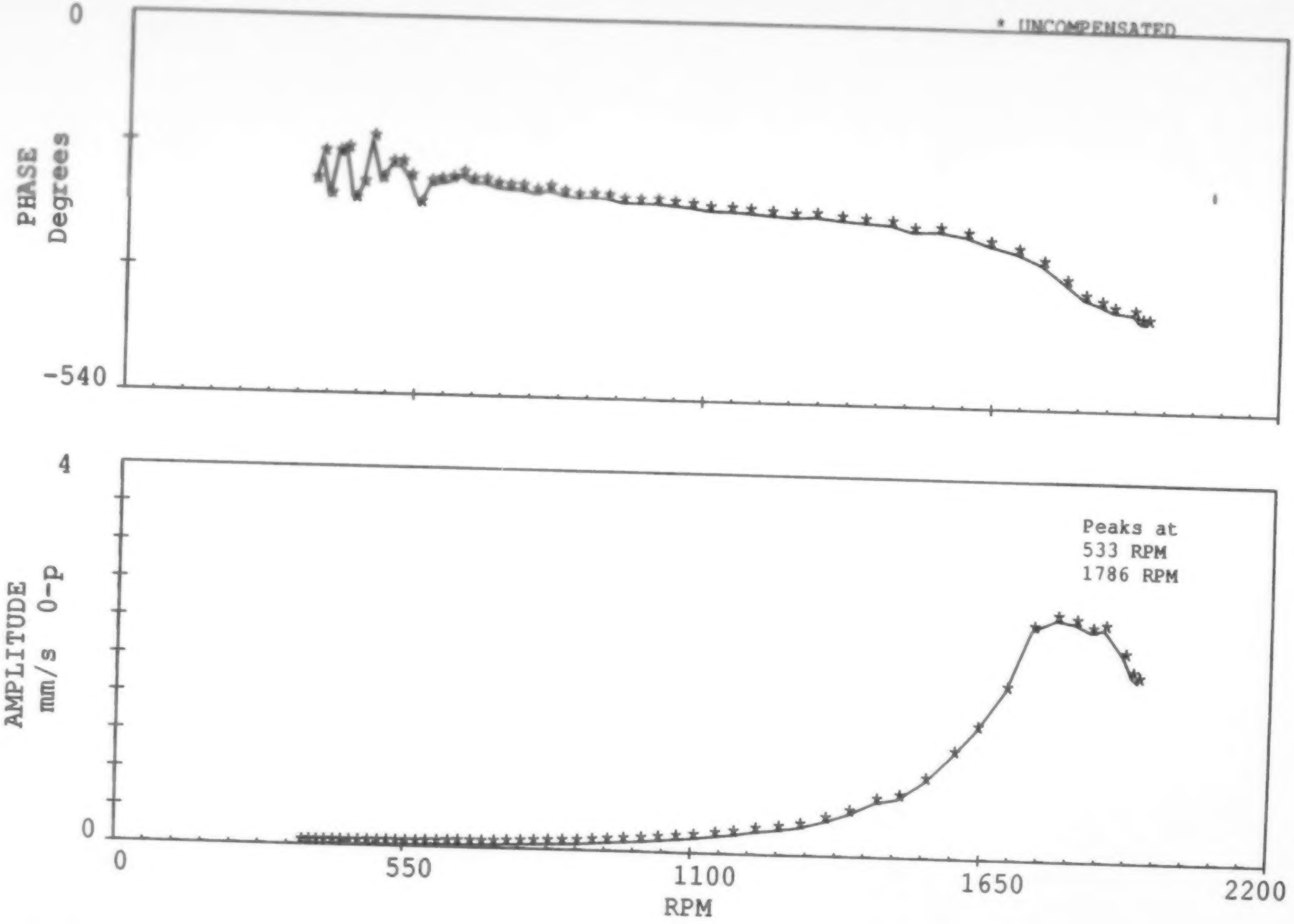


FIGURE H2

DARLINGTON NGS A EMERGENCY POWER GENERATOR #1
AC GENERATOR HOT RUNDOWN IB BRG CASING VELOCITY VERT.

BODE PLOT Order : 1.00
Date : 7-NOV-88

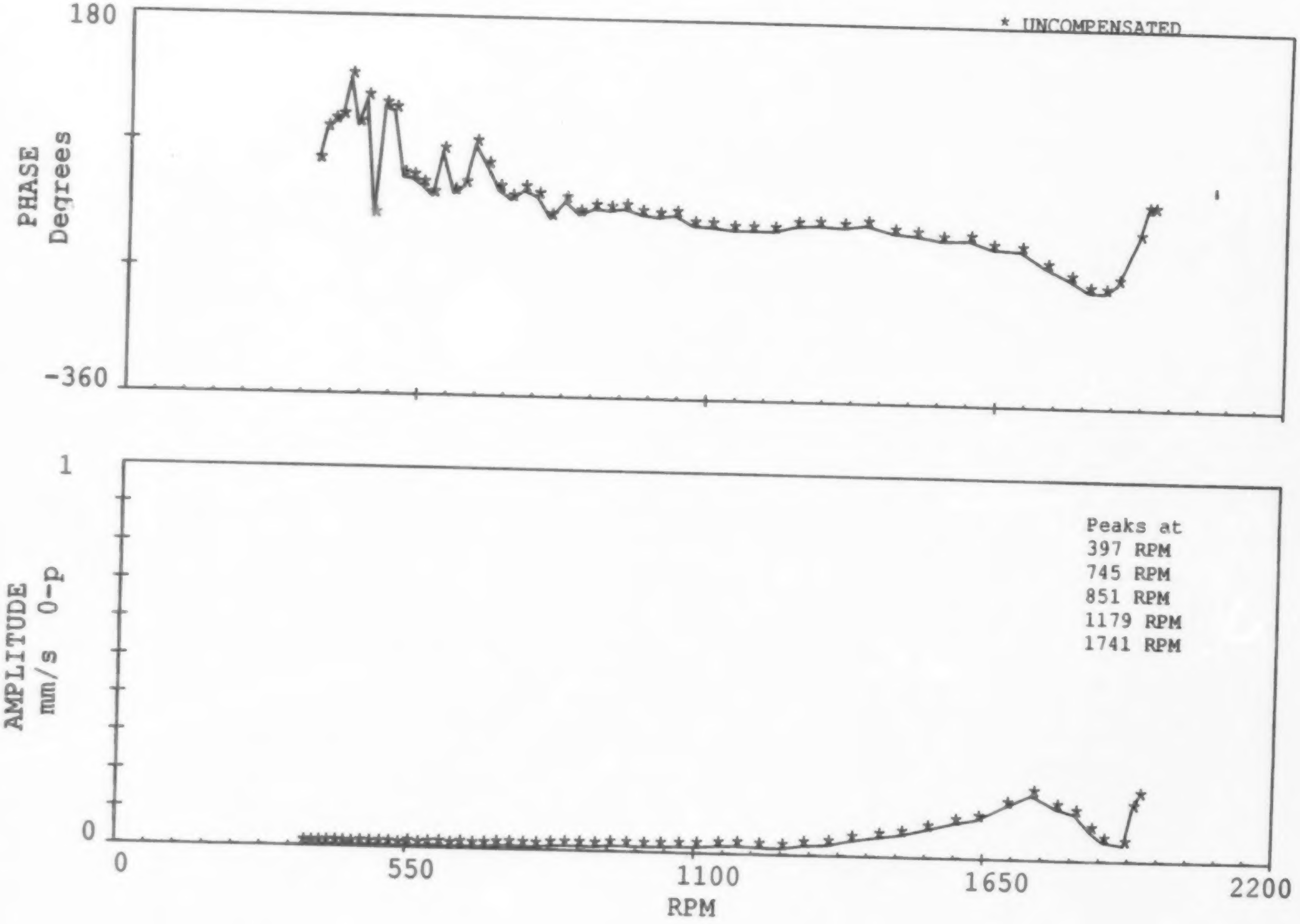


FIGURE H3

DARLINGTON NGS A EMERGENCY POWER GENERATOR #1
AC GENERATOR HOT RUNDOWN IB BRG CASING VELOCITY HOR.

BODE PLOT Order : 1.00
Date : 7-NOV-88

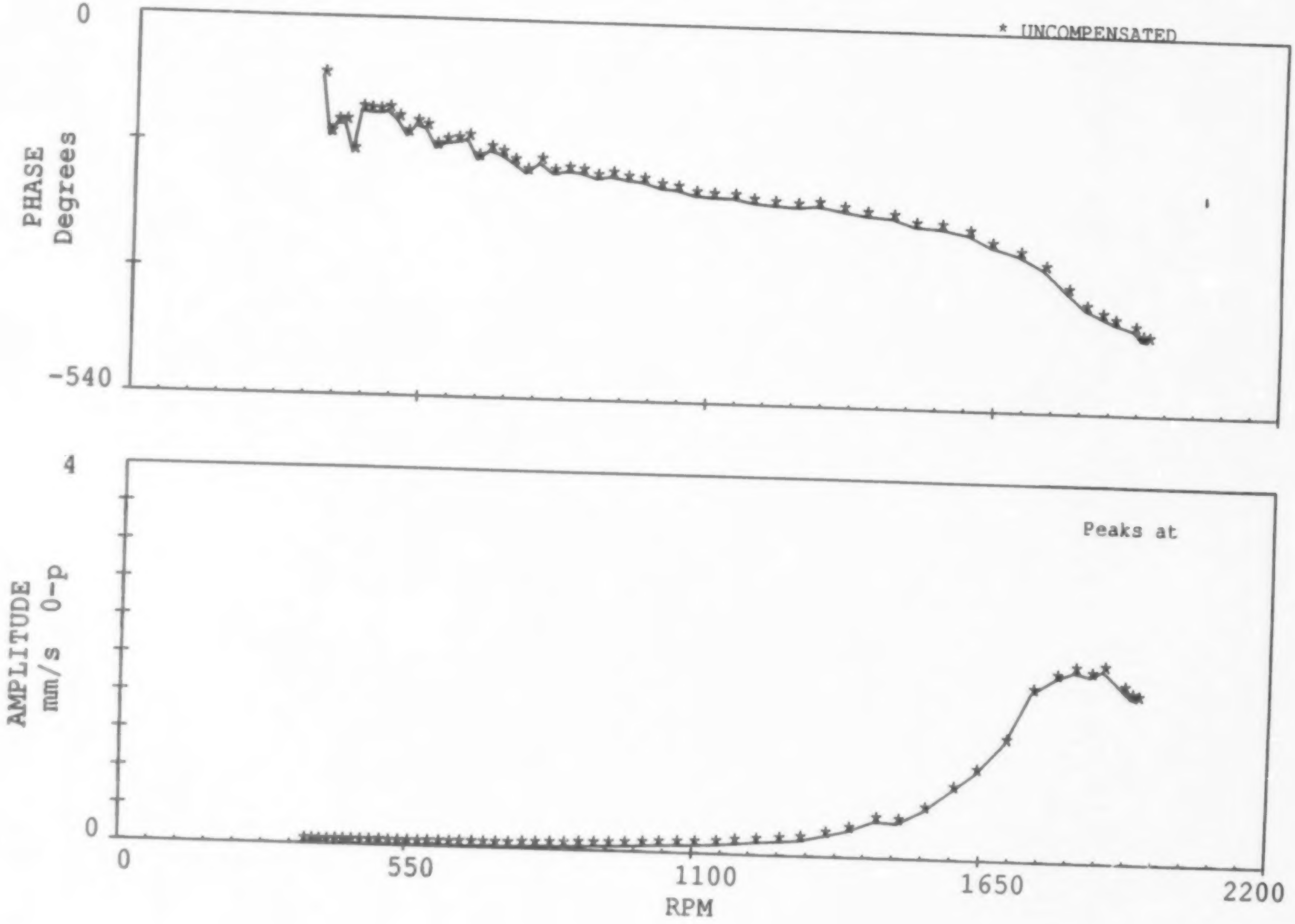


FIGURE H4

90-338

DARLINGTON NGS A EMERGENCY POWER GENERATOR #1
POWER TURBINE HOT RUNDOWN BRG #5 CASING VELOCITY VERT.
BODE PLOT     Order : 1.00
Date : 7-NOV-88

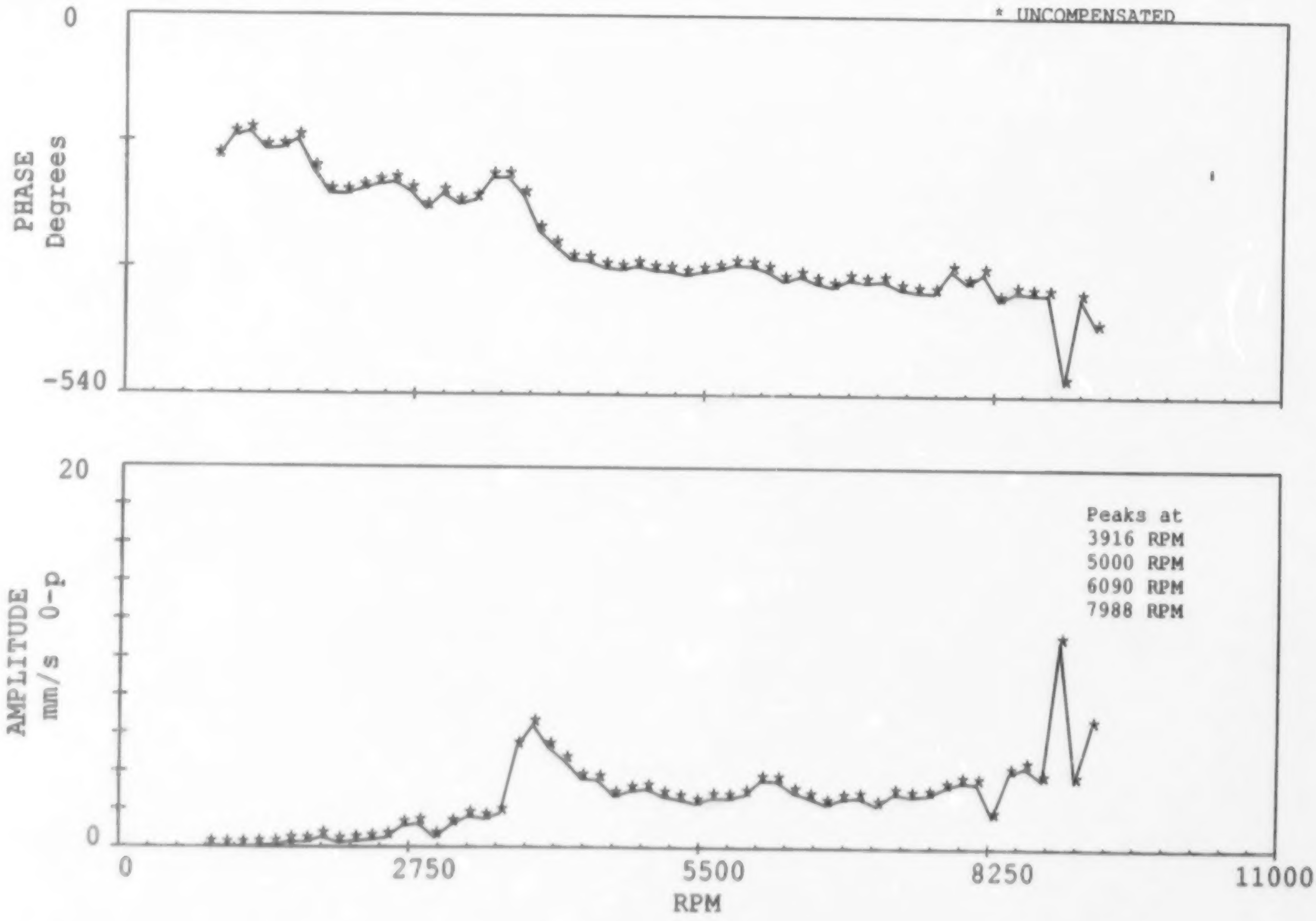


FIGURE H5

DARLINGTON NGS A EMERGENCY POWER GENERATOR #1
POWER TURBINE HOT RUNDOWN BRG #5 CASING VELOCITY HOR.

BODE PLOT Order : 1.00
Date : 7-NOV-88

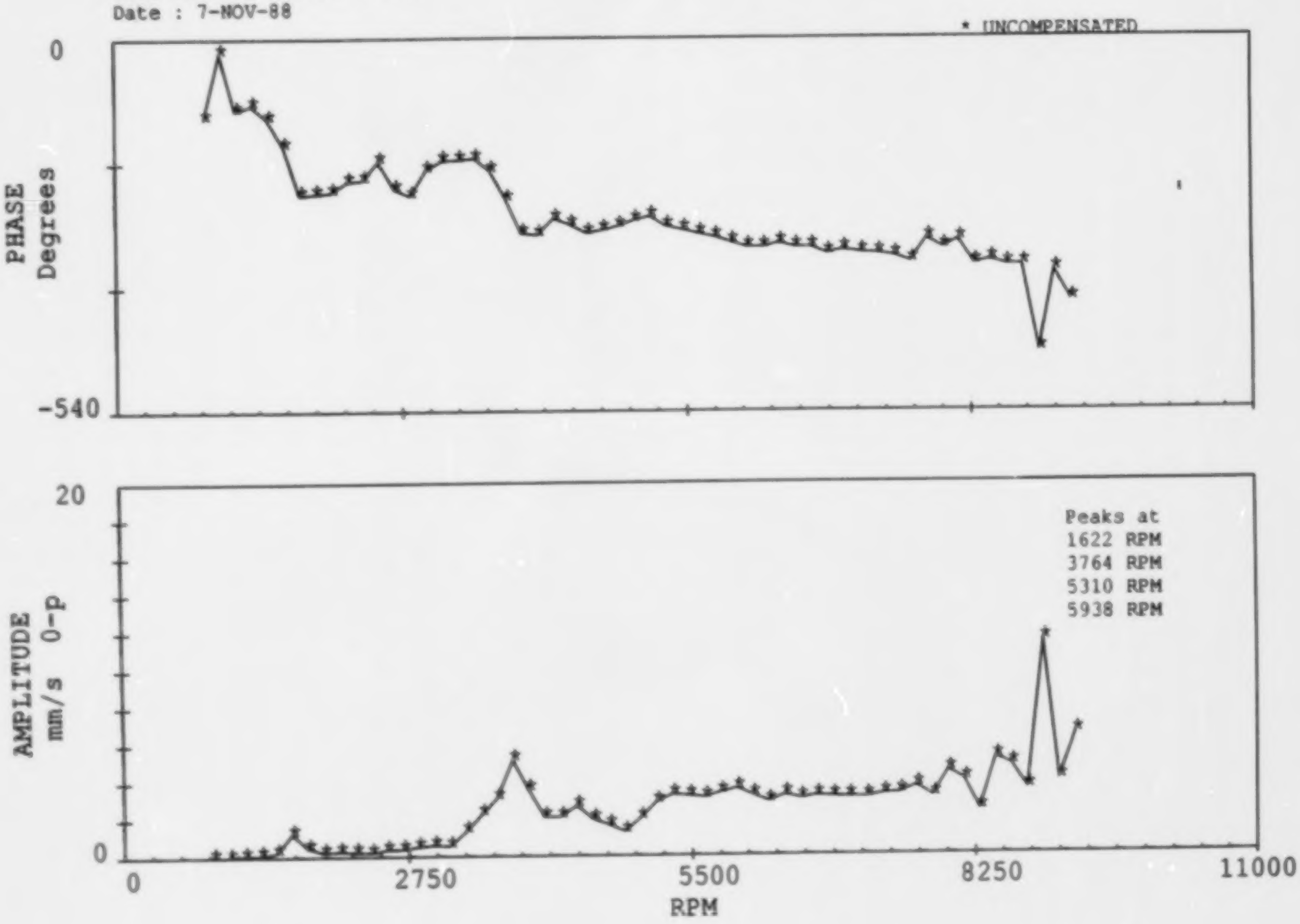


FIGURE H6

DARLINGTON NGS A EMERGENCY POWER GENERATOR #1
POWER TURBINE HOT RUNDOWN BRG #5 CASING VELOCITY AXIAL

BODE PLOT Order : 1.00
Date : 7-NOV-88

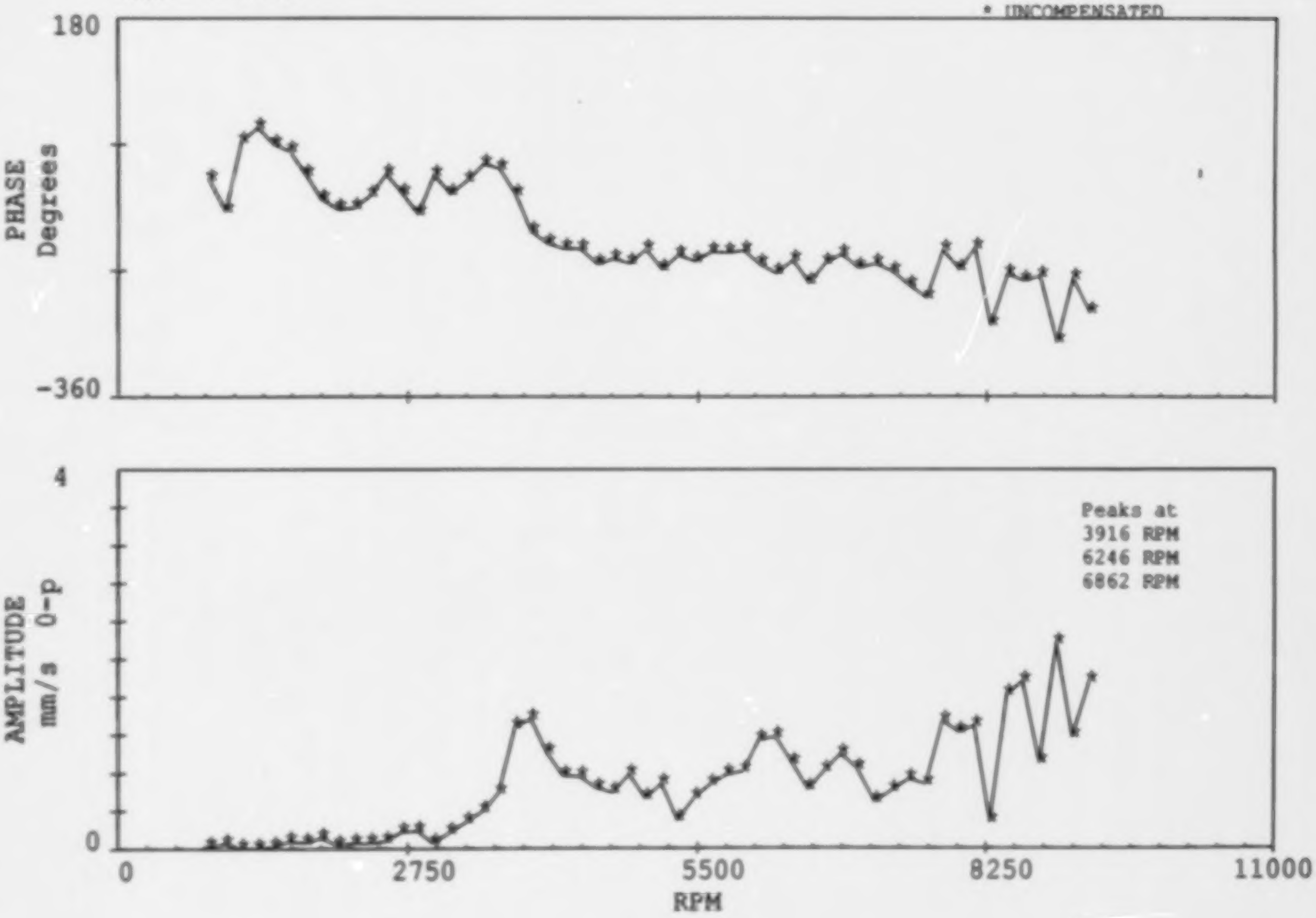


FIGURE H7

DARLINGTON NGS A EMERGENCY POWER GENERATOR #1
AC GENERATOR HOT RUNDOWN SHAFT DISPLACEMENT OB BRG VERT

BODE PLOT Order : 1.00
Date : 7-NOV-88

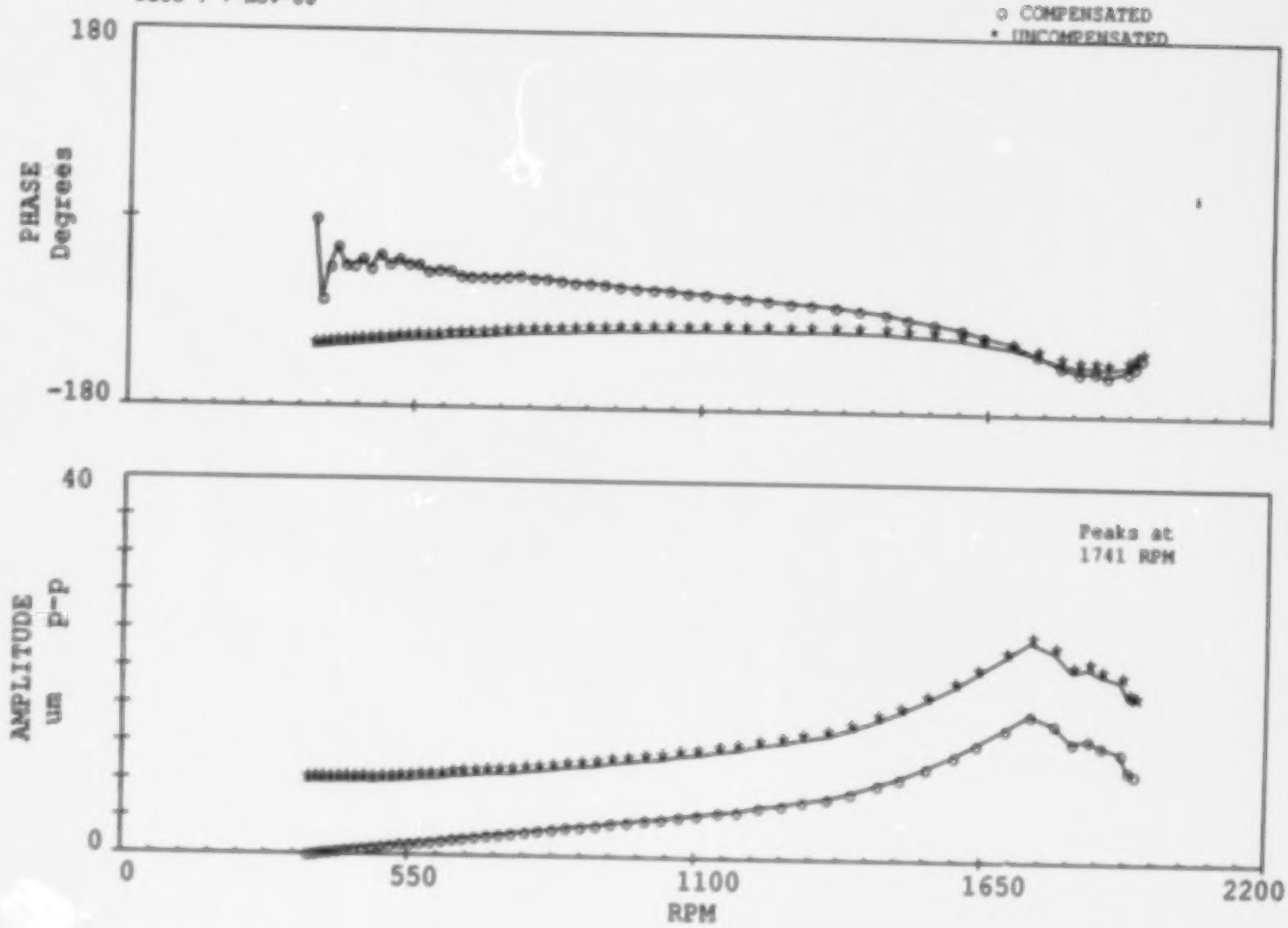


FIGURE H8

90-338

DARLINGTON NGS A EMERGENCY POWER GENERATOR #1
AC GENERATOR HOT RUNDOWN SHAFT DISPLACEMENT OB BRG HOR.

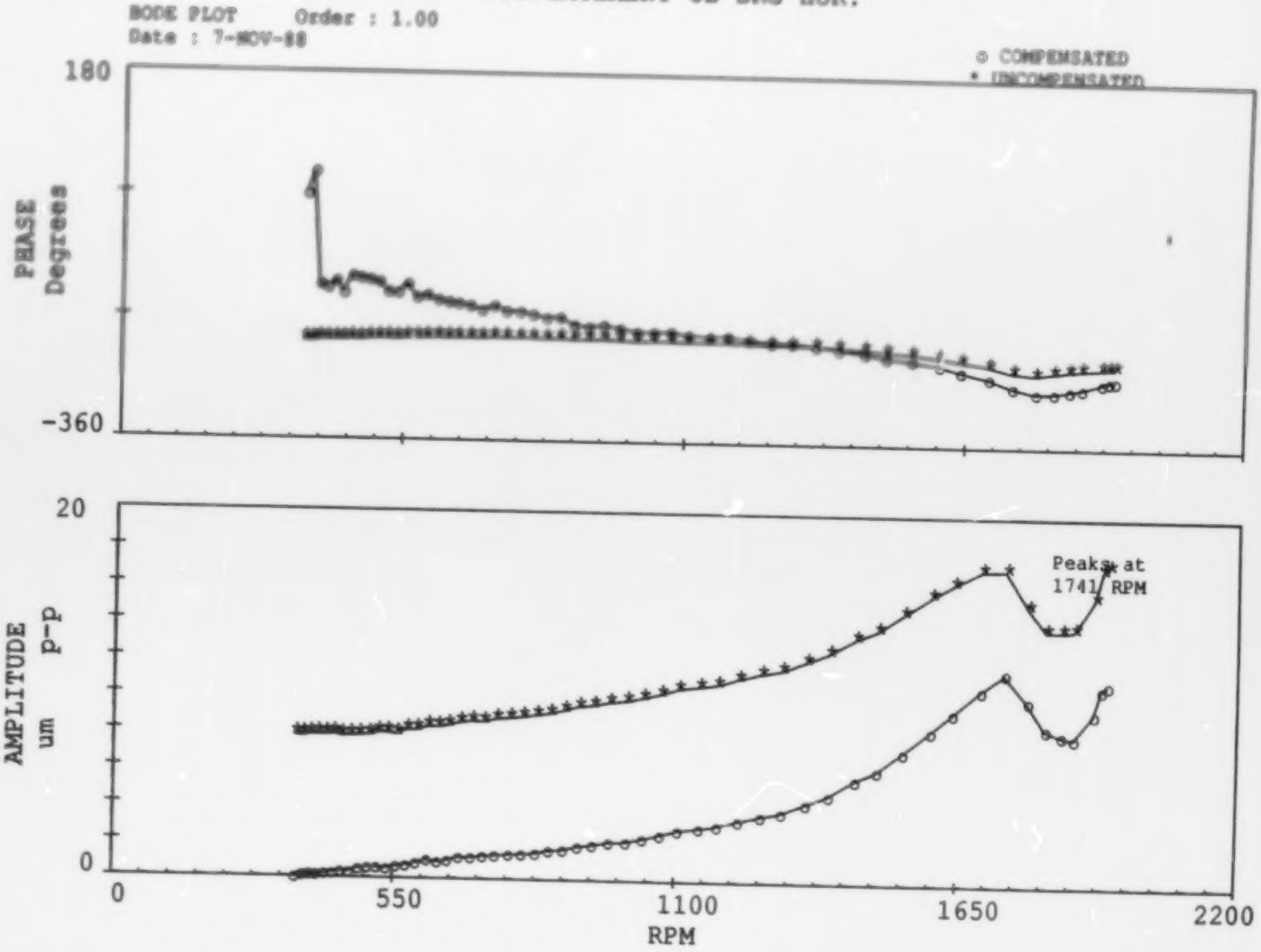


FIGURE H9

DARLINGTON NGS A EMERGENCY POWER GENERATOR #1
AC GENERATOR HOT RUNDOWN SHAFT DISPLACEMENT IB BRG VERT

BODE PLOT    Order : 1.00
Date : 7-NOV-88

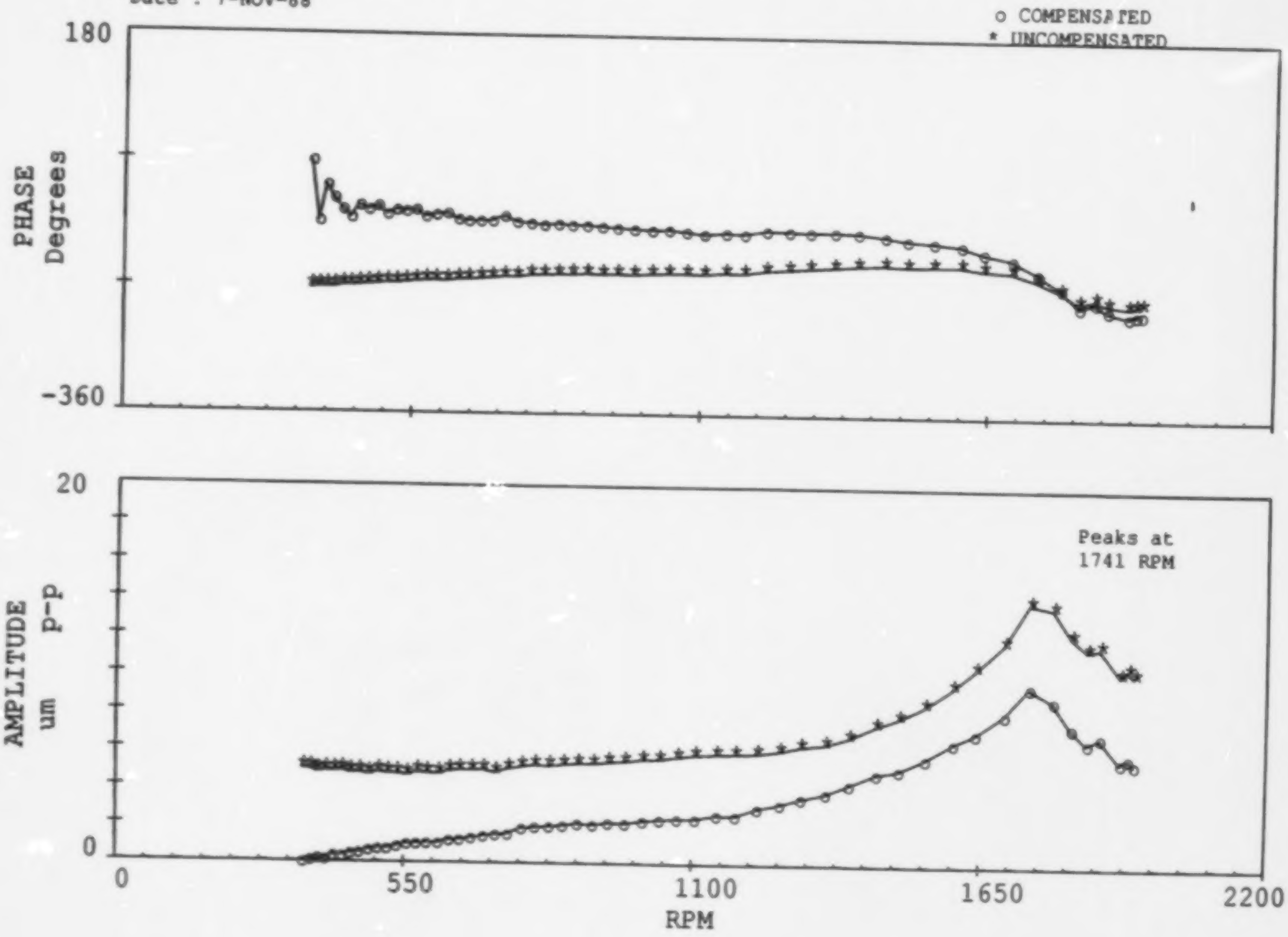


FIGURE H10

DARLINGTON NGS A EMERGENCY POWER GENERATOR #1
AC GENERATOR HOT RUNDOWN SHAFT DISPLACEMENT IB BRG HOR.

BODE PLOT      Order : 1.00
Date : 7-NOV-88

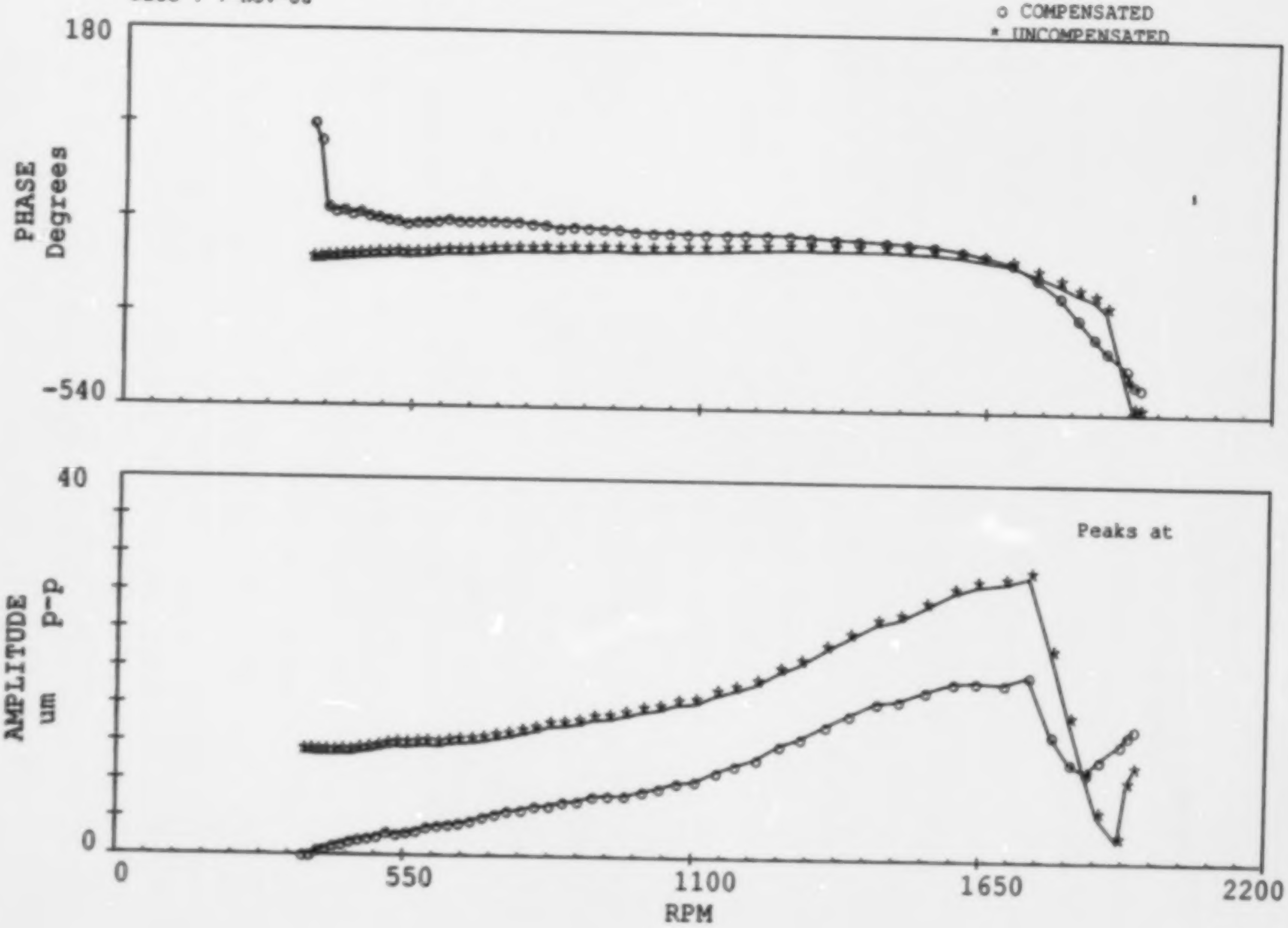


FIGURE H11

90-338

DARLINGTON NGS A EMERGENCY POWER GENERATOR #1
POWER TURBINE HOT RUNDOWN BRG #4 SHAFT DISPLACEMENT VERT

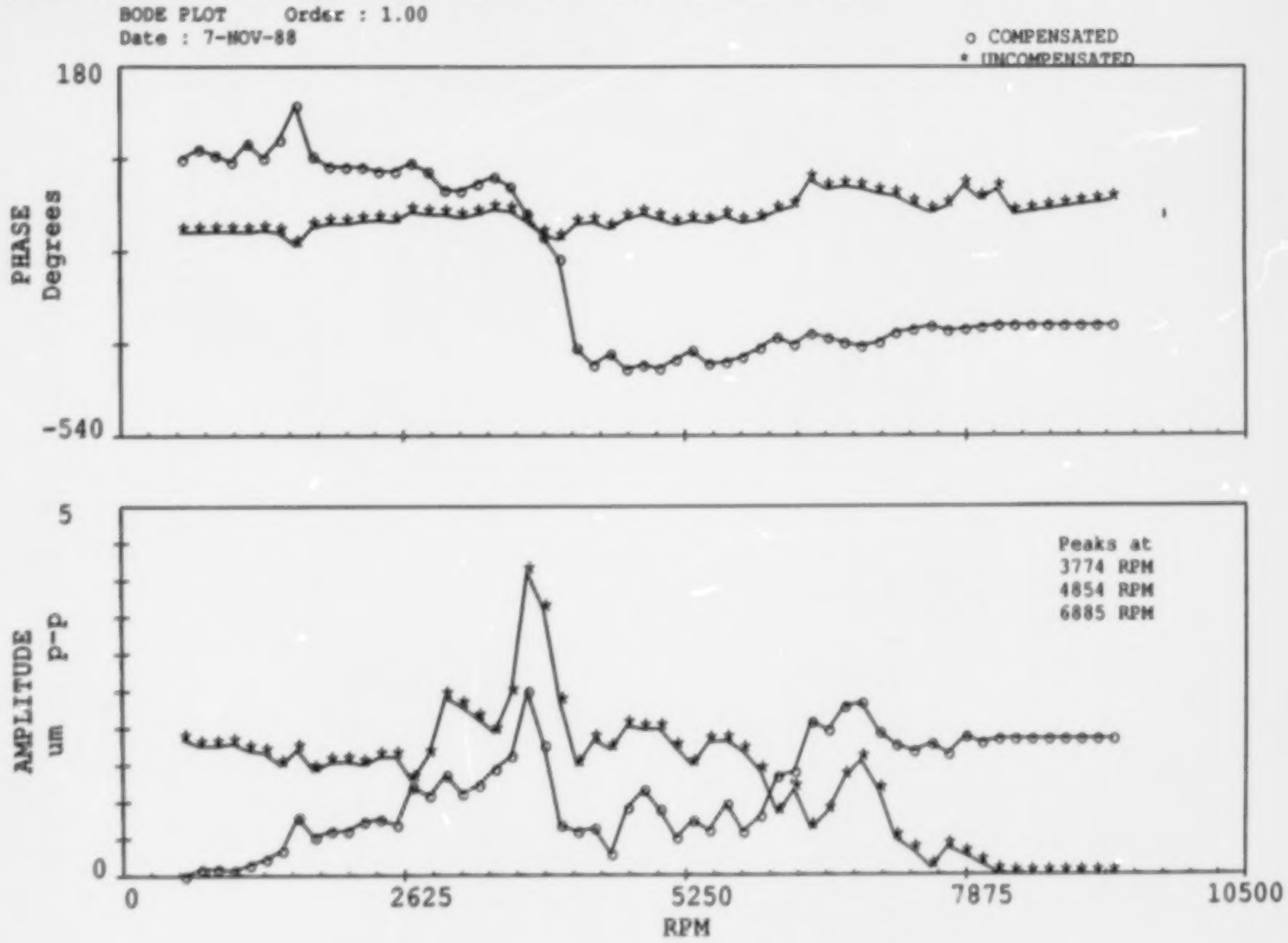


FIGURE H12

DARLINGTON NGS A EMERGENCY POWER GENERATOR #1
POWER TURBINE HOT RUNDOWN BRG #4 SHAFT DISPLACEMENT HOR.

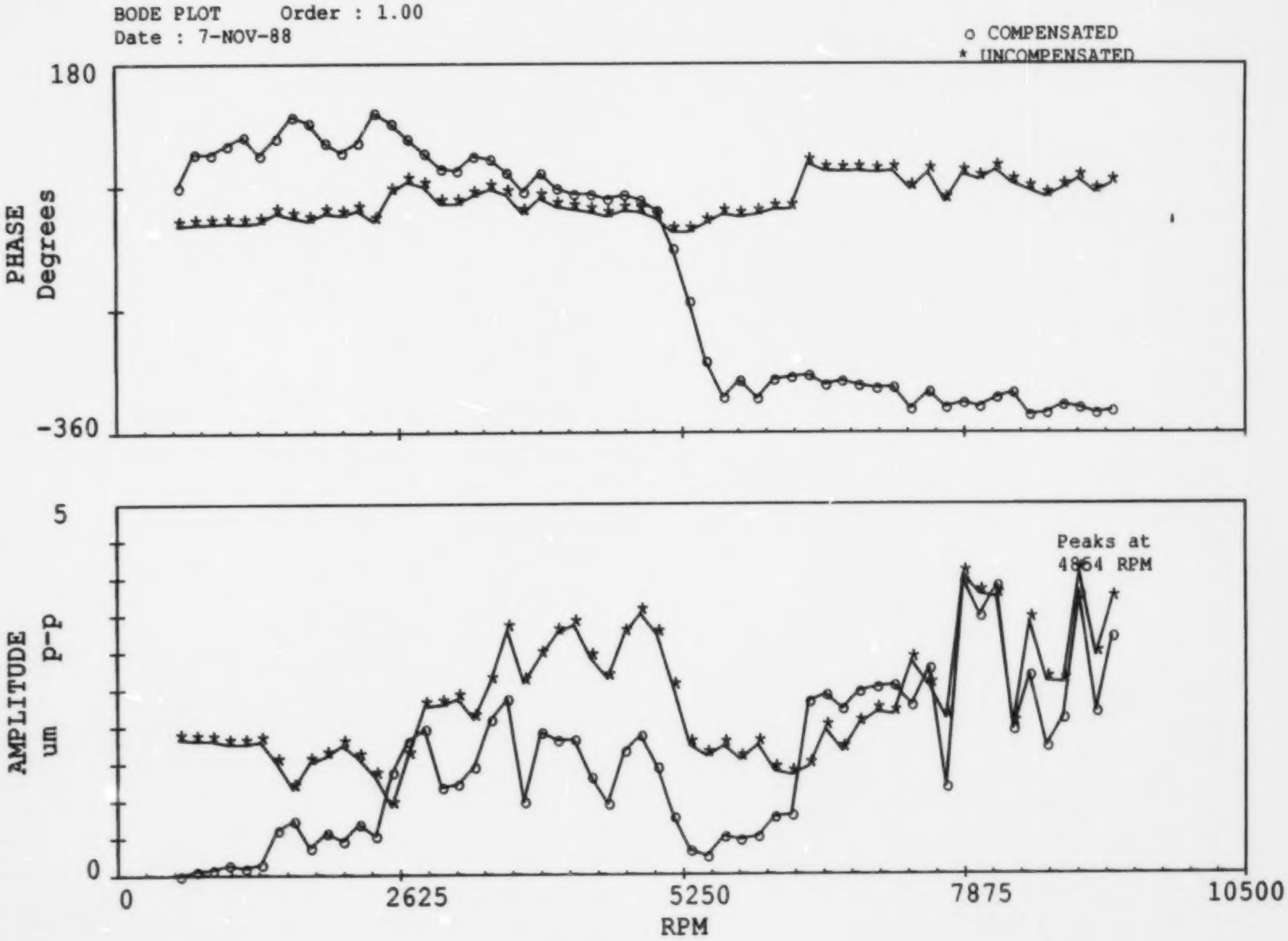


FIGURE H13

DARLINGTON NGS A EMERGENCY POWER GENERATOR #1
POWER TURBINE HOT RUNDOWN BRG #5 SHAFT DISPLACEMENT VERT

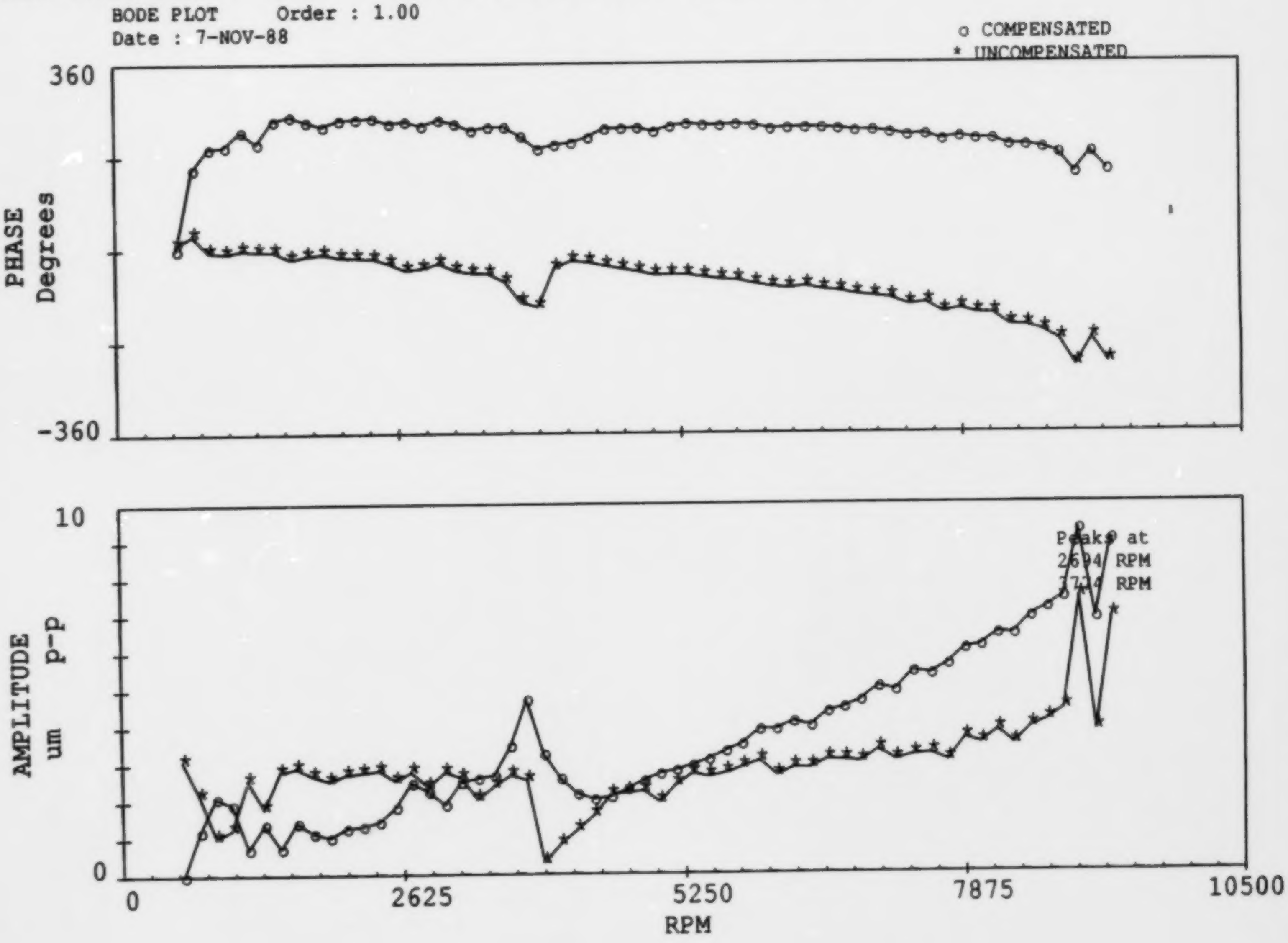


FIGURE H14

DARLINGTON NGS A EMERGENCY POWER GENERATOR #1
POWER TURBINE HOT RUNDOWN BRG #5 SHAFT DISPLACEMENT HOR.

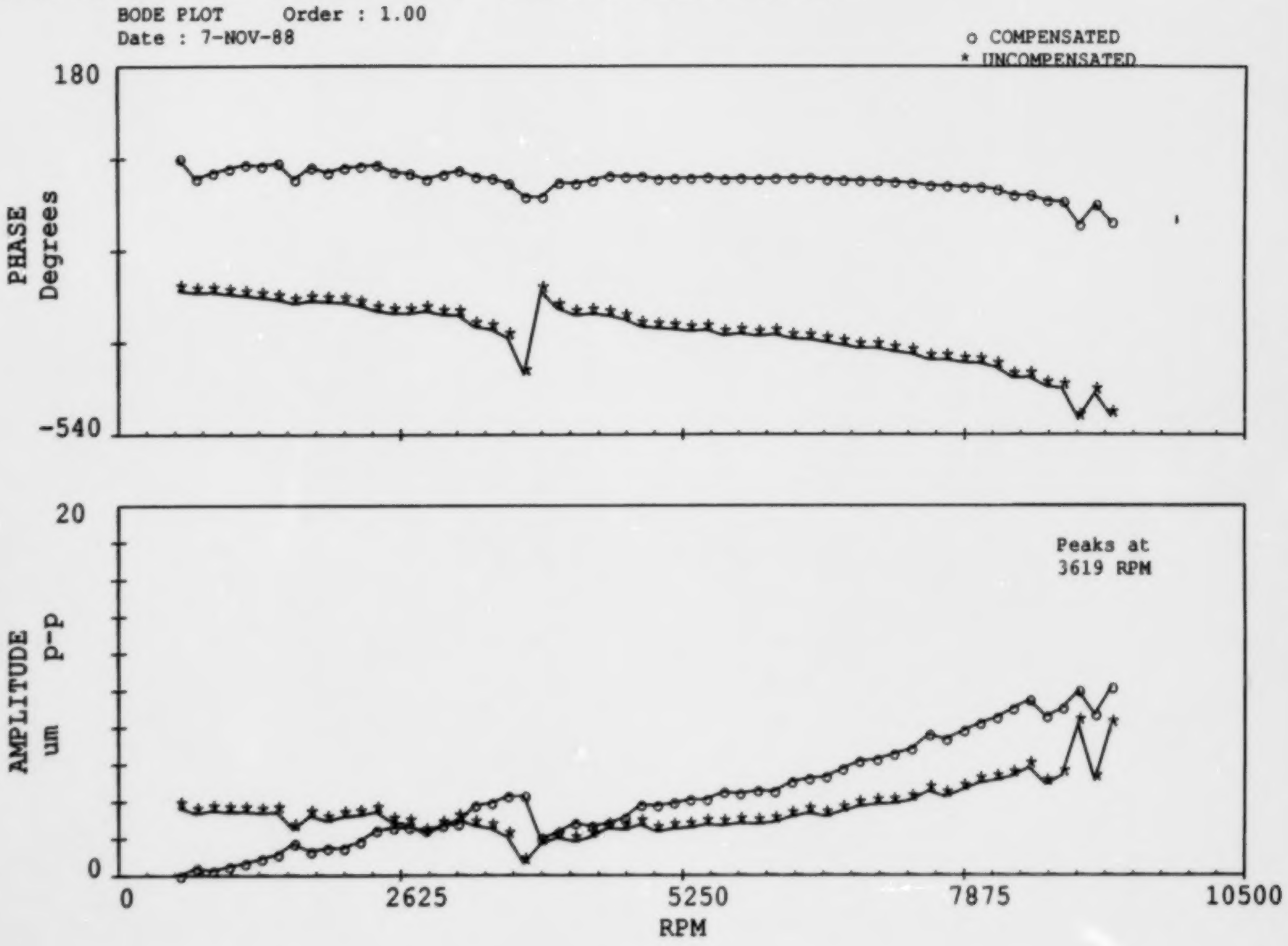


FIGURE H15

DARLINGTON NGS A EMERGENCY POWER GENERATOR #1
GAS GENERATOR HOT RUNDOWN BRG #1 SHAFT DISPLACEMENT VERT

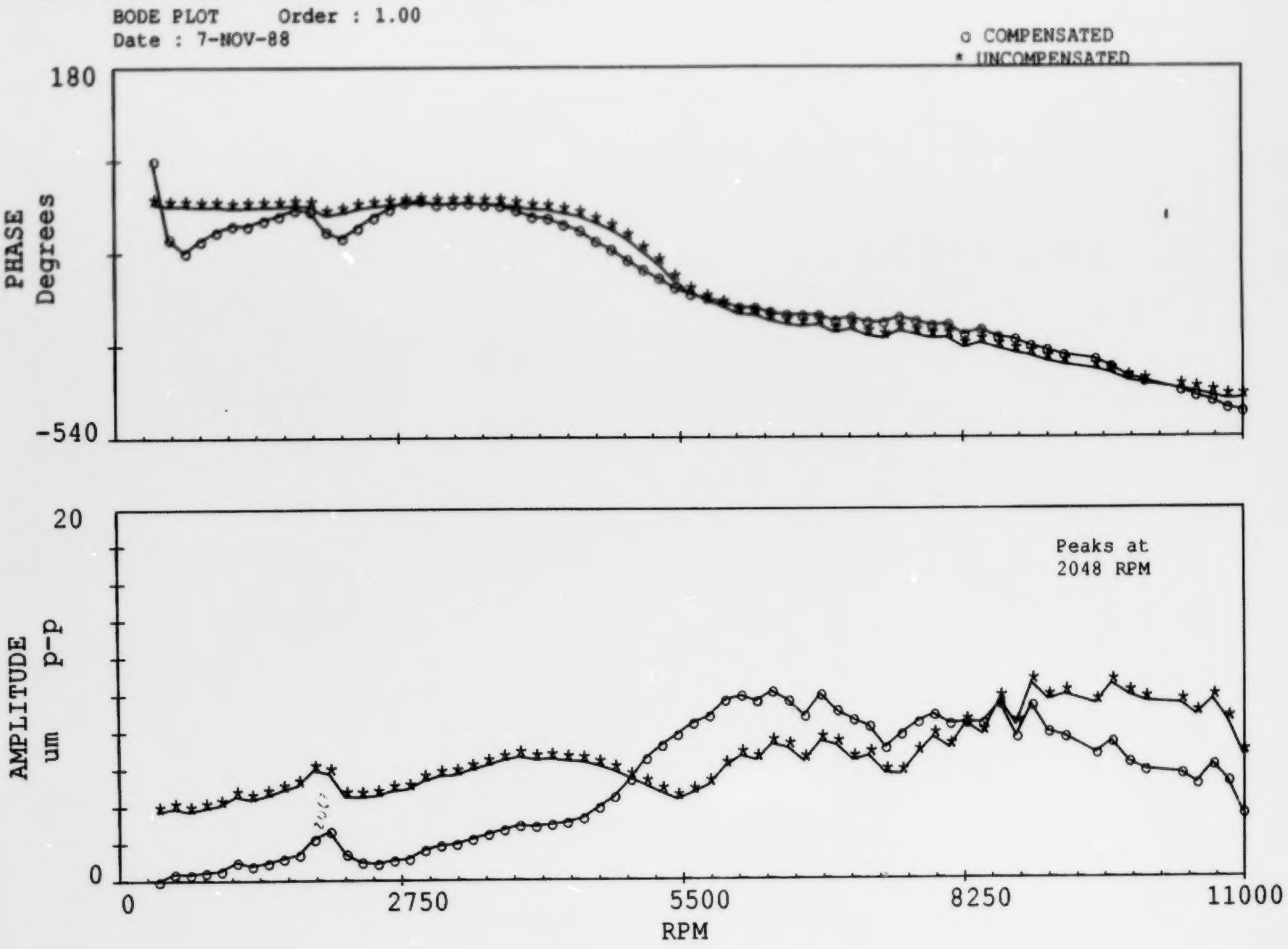


FIGURE H16

DARLINGTON NGS A EMERGENCY POWER GENERATOR #1
GAS GENERATOR HOT RUNDOWN BRG #1 SHAFT DISPLACEMENT HOR.

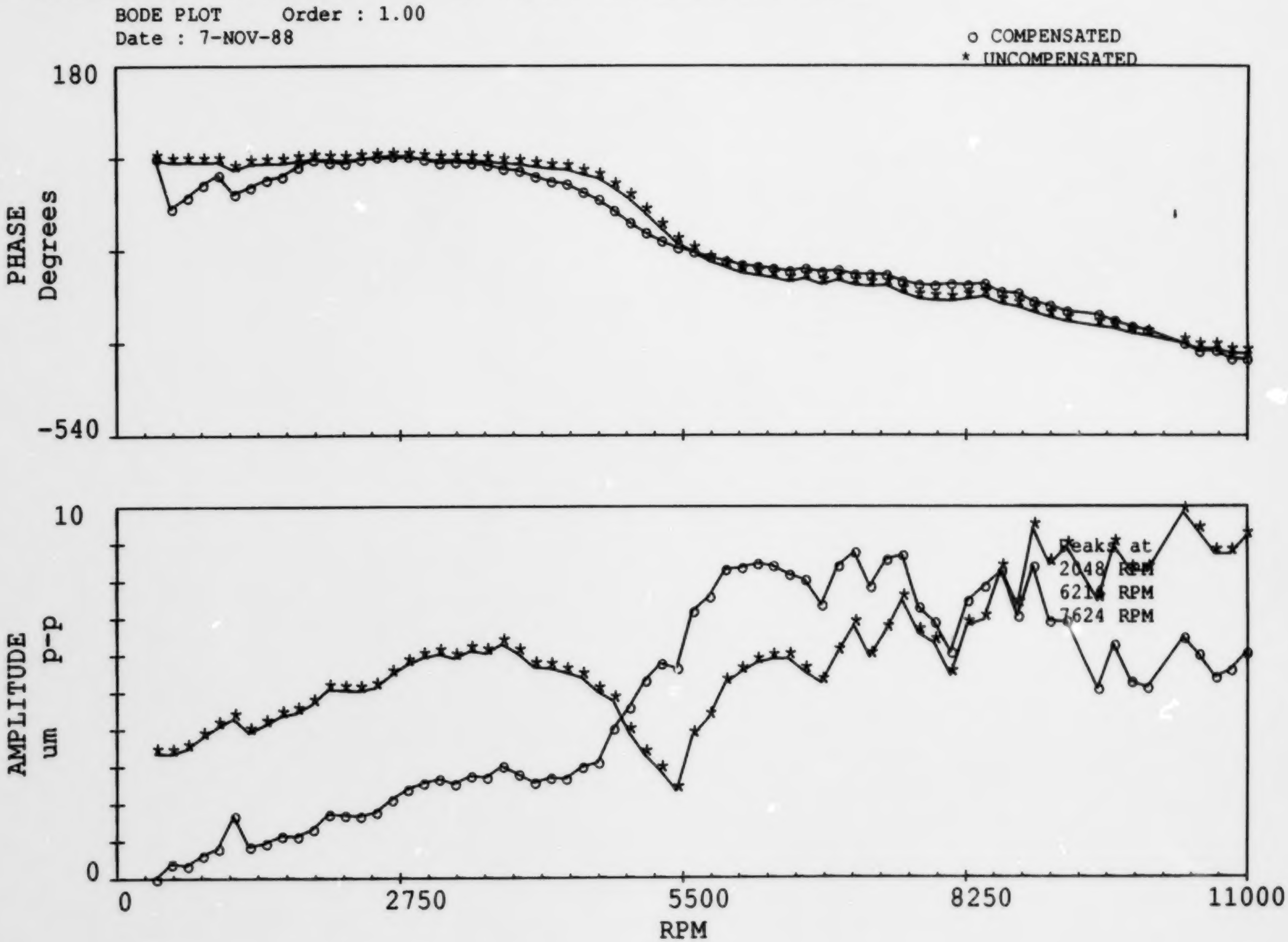


FIGURE H17

DARLINGTON NGS A EMERGENCY POWER GENERATOR #1
GAS GENERATOR HOT RUNDOWN BRG #2 SHAFT DISPLACEMENT VERT

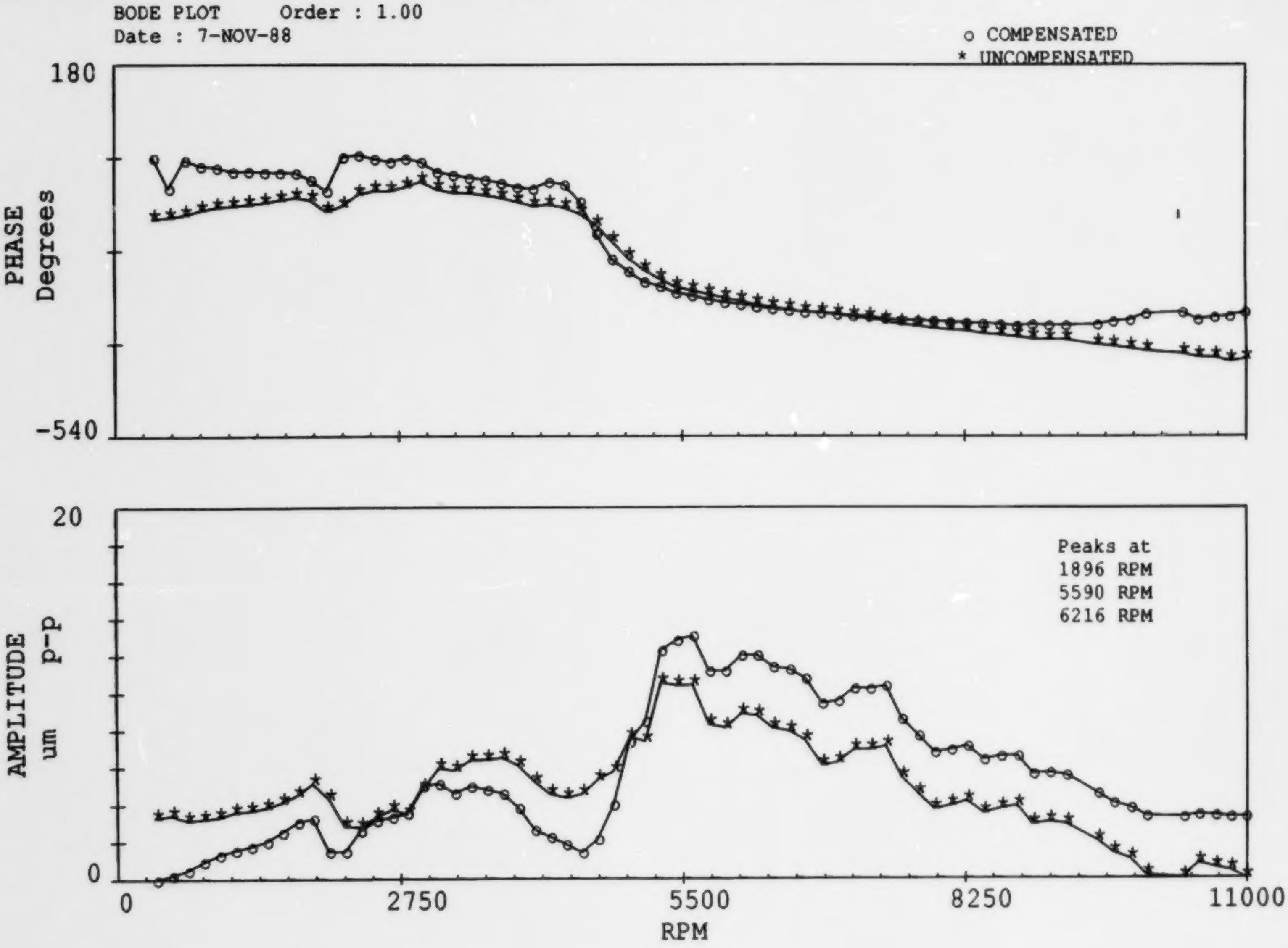


FIGURE H18

DARLINGTON NGS A EMERGENCY POWER GENERATOR #1
GAS GENERATOR HOT RUNDOWN BRG #2 SHAFT DISPLACEMENT HOR.

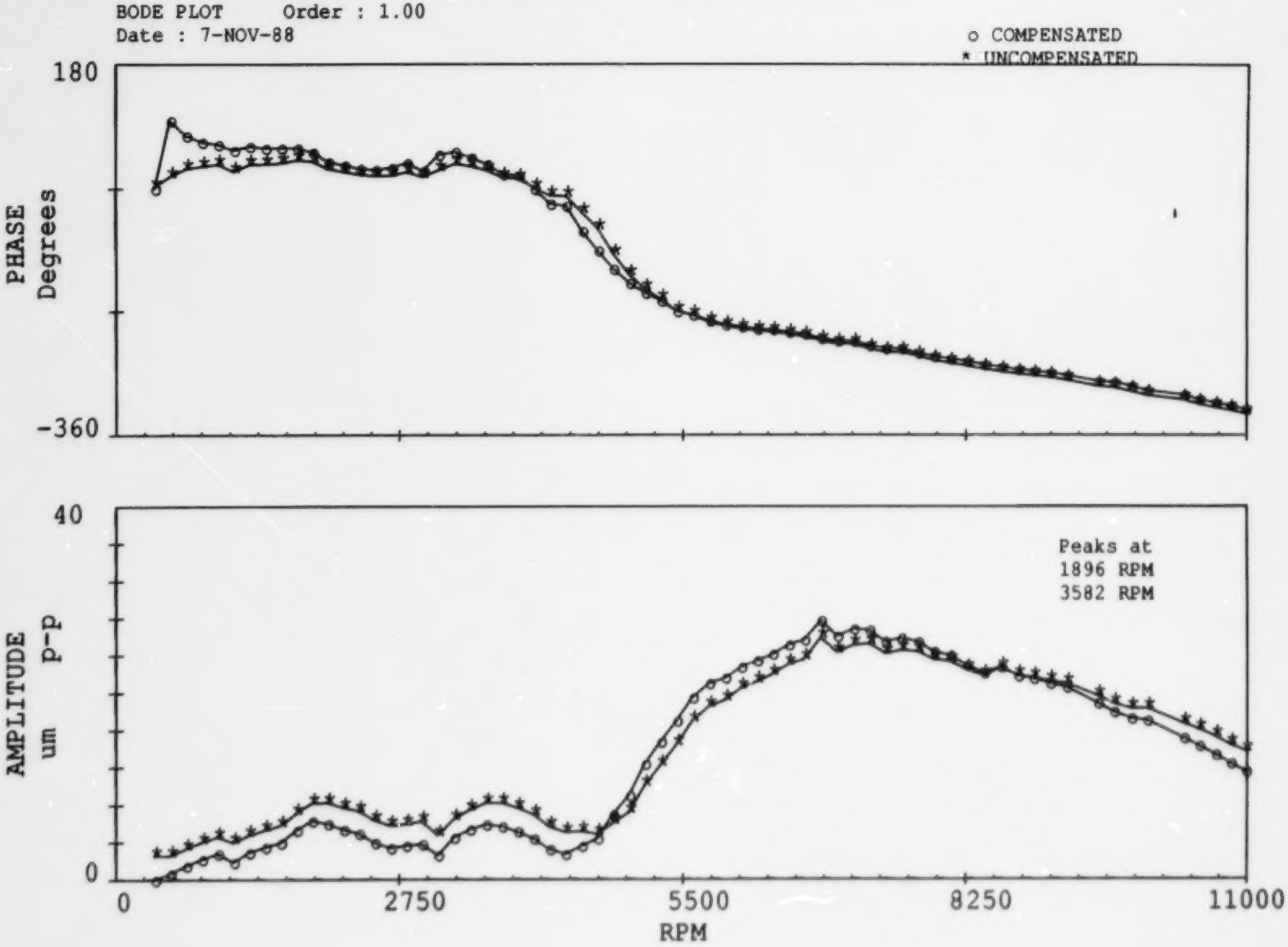


FIGURE H19

DARLINGTON NGS A EMERGENCY POWER GENERATOR #1
GAS GENERATOR HOT RUNDOWN BRG #3 SHAFT DISPLACEMENT VERT

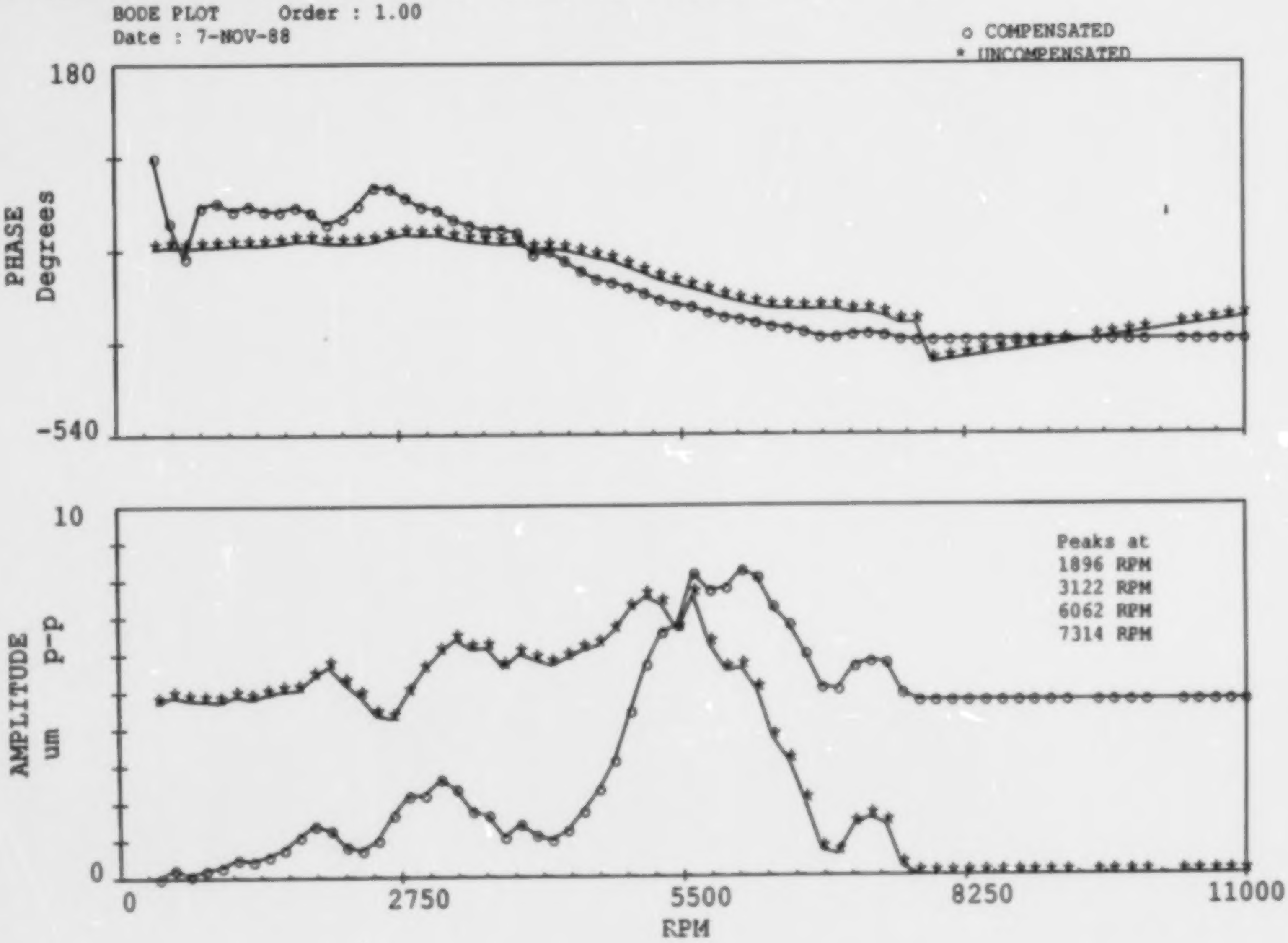


FIGURE H20

DARLINGTON NGS A EMERGENCY POWER GENERATOR #1
GAS GENERATOR HOT RUNDOWN BRG #3 SHAFT DISPLACEMENT HOR.

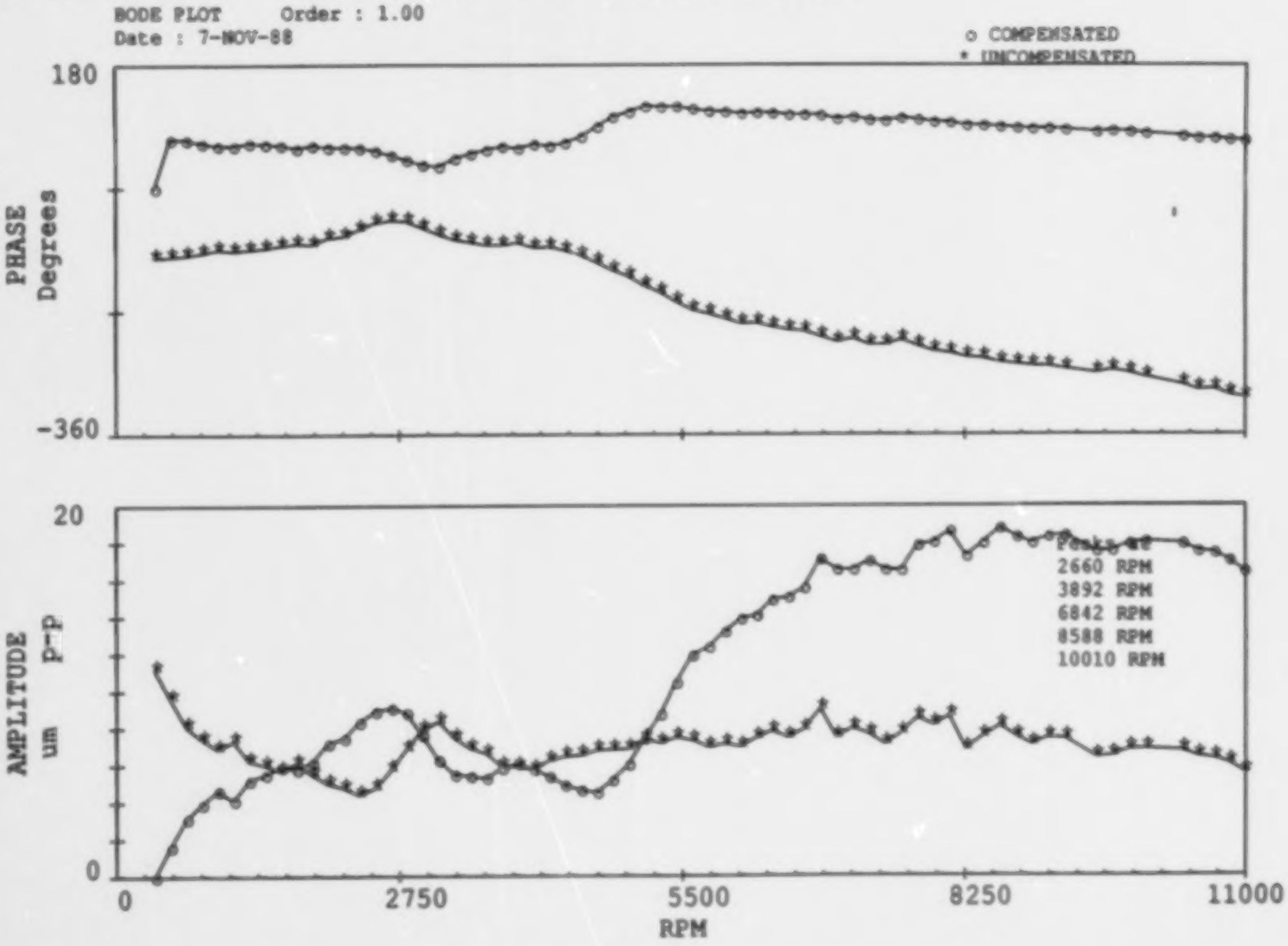


FIGURE H21

# APPENDIX I

# IMPACT SPECTRA

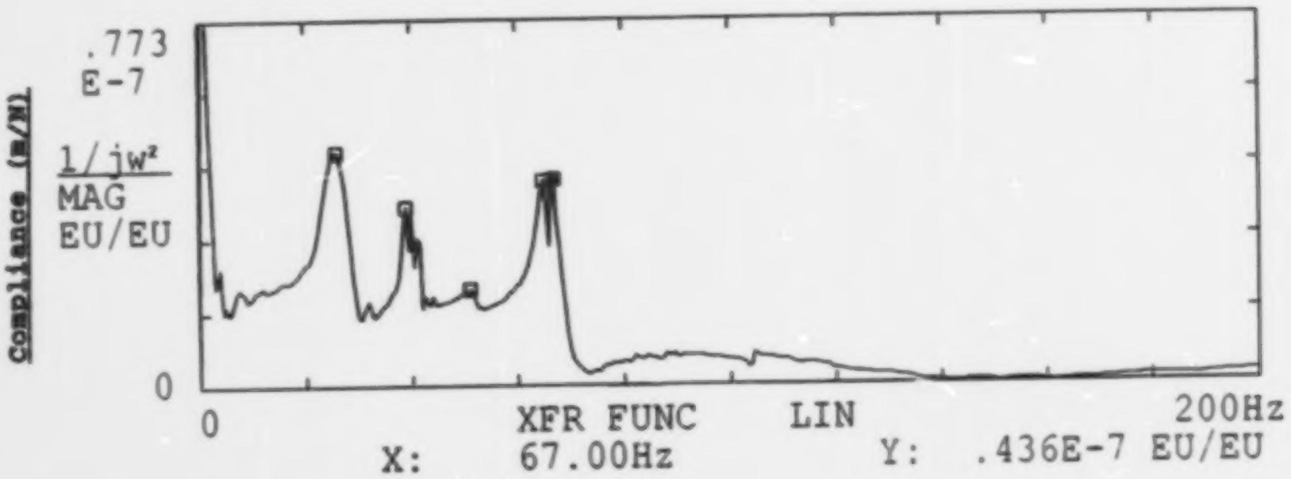
## TABLE I1
## DARLINGTON NGS 'A' EMERGENCY POWER GENERATOR #1
## FIGURE NUMBERS OF IMPACT SPECTRA

| Measurement Location | | Impact Spectrum Figure No |
|---|---|---|
| Exciter | - Vertical Direction | I1 |
| | - Horizontal Direction | I2 |
| AC Generator Outboard Bearing Casing | - Vertical Direction | I3 |
| | - Horizontal Direction | I4 |
| AC Generator Inboard Bearing Casing | - Vertical Direction | I5 |
| | - Horizontal Direction | I6 |
| | - Axial Direction | I7 |
| Reduction Gearbox | - Vertical Direction | I8 |
| | - Horizontal Direction | I9 |
| | - Axial Direction | I10 |
| Power Turbine Bearing No 5 Casing | - Vertical Direction | I11 |
| | - Horizontal Direction | I12 |
| Gas Producer (Near Bearing No 2) Casing | - Vertical Direction | I13 |
| | - Horizontal Direction | I14 |

## FIGURE I1

## DNGS 'A' EMERGENCY POWER GENERATOR #1 - IMPACT SPECTRUM
## EXCITER VERTICAL DIRECTION

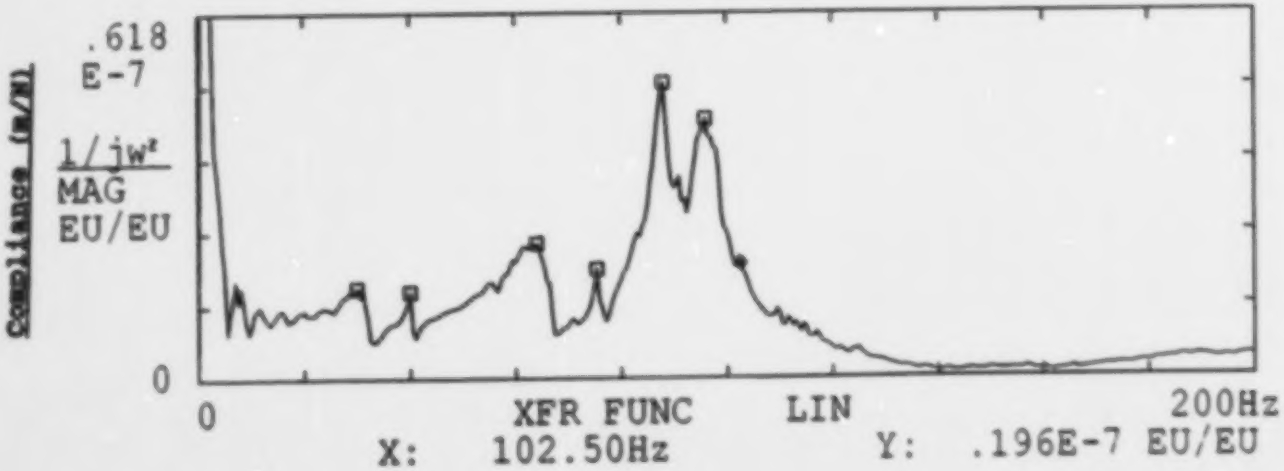
```
                  XFER FUNC  MAG - PH
1      26.00Hz         .493E-7 EU/EU   -44.9 deg
2      39.00           .379E-7         -54.4
3      51.00           .205E-7         -74.6
4      65.00           .433E-7        -117.6
5      67.00           .436E-7        -157.8
6
7
8
9
10
```



00:52

# FIGURE I2
# DNGS 'A' EMERGENCY POWER GENERATOR #1 - IMPACT SPECTRUM
# EXCITER HORIZONTAL DIRECTION

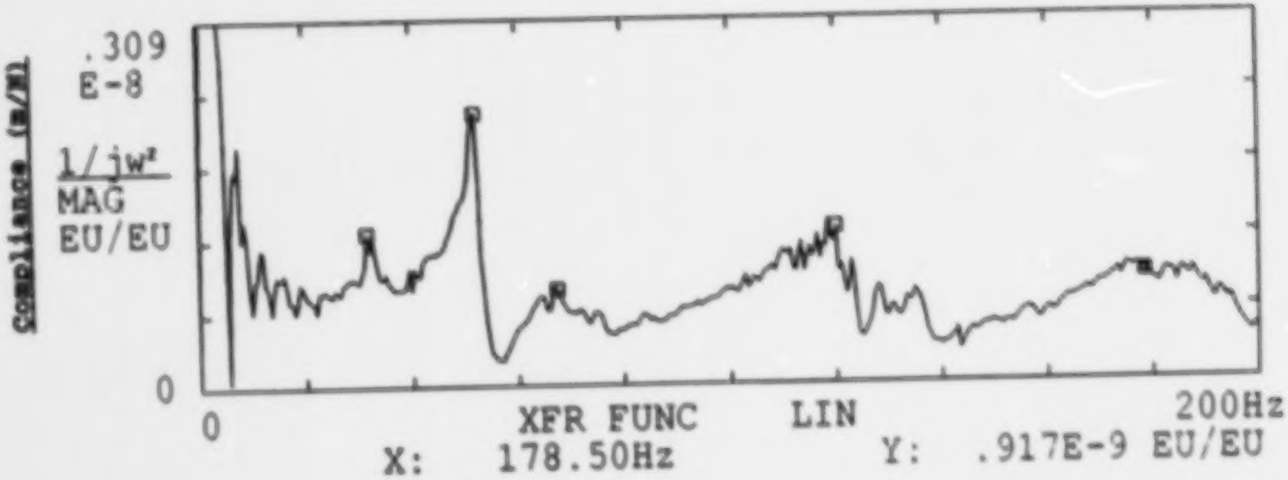
```
                    XFER FUNC  MAG - PH
 1     30.00Hz          .156E-7 EU/EU    -23.9 deg
 2     40.00            .151E-7          -17.6
 3     64.00            .231E-7          -46.9
 4     75.50            .186E-7          -29.6
 5     88.00            .503E-7          -57.7
 6     96.00            .440E-7         -101.1
 7
 8
 9
10
```



00:53

**FIGURE I3**
**DNGS 'A' EMERGENCY POWER GENERATOR #1 - IMPACT SPECTRUM**
**AC GENERATOR OUTBOARD BEARING CASING VERTICAL DIRECTION**

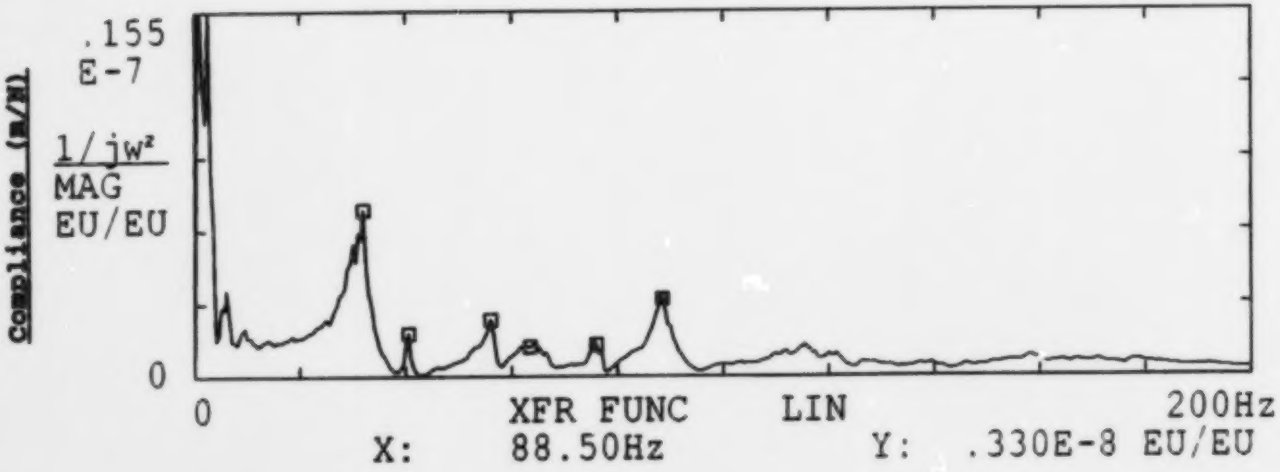
```
                  XFER FUNC  MAG - PH
 1      31.50Hz        .130E-8 EU/EU     6.8 deg
 2      52.00          .230E-8          -78.9
 3      67.50          .816E-9          -25.4
 4     120.00          .133E-8          -60.4
 5     178.50          .917E-9          -60.0
 6
 7
 8
 9
10
```



00:03

## FIGURE I4
## DNGS 'A' EMERGENCY POWER GENERATOR #1 - IMPACT SPECTRUM
## AC GENERATOR OUTBOARD BEARING CASING HORIZONTAL DIRECTION

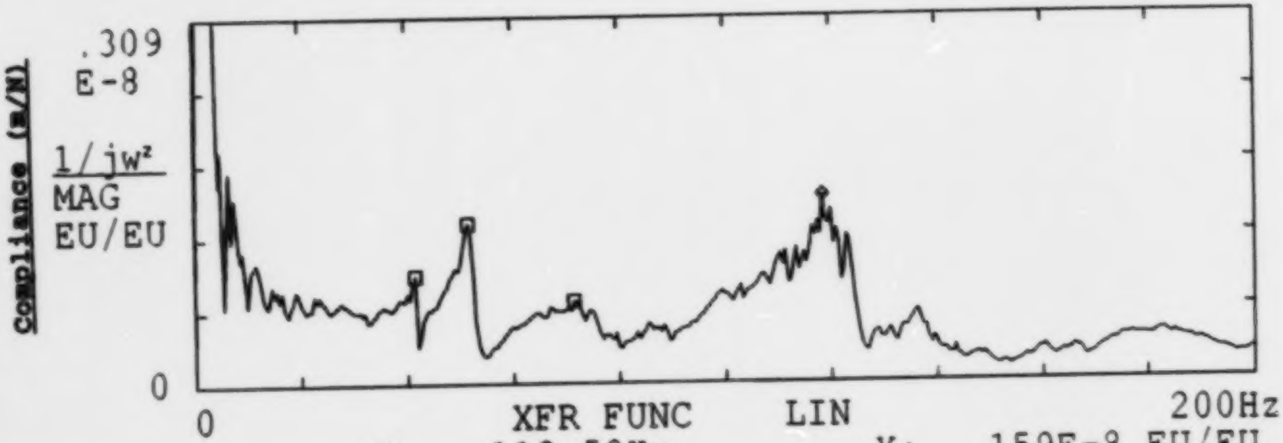
```
                XFER FUNC  MAG - PH
 1      32.00Hz         .708E-8 EU/EU    75.5 deg
 2      40.50           .186E-8          74.9
 3      56.00           .242E-8         116.4
 4      63.50           .126E-8         116.1
 5      76.00           .138E-8          92.8
 6      88.50           .330E-8          88.6
 7
 8
 9
10
```



00:51

## FIGURE 15
## DNGS 'A' EMERGENCY POWER GENERATOR #1 - IMPACT SPECTRUM
## AC GENERATOR INBOARD BEARING CASING VERTICAL DIRECTION

|  |  | XFER FUNC | MAG - PH |
|---|---|---|---|
| 1 | 41.50Hz | .925E-9 EU/EU | -46.1 deg |
| 2 | 51.50 | .136E-8 | -56.7 |
| 3 | 71.50 | .705E-9 | -32.7 |
| 4 |  |  |  |
| 5 |  |  |  |
| 6 |  |  |  |
| 7 |  |  |  |
| 8 |  |  |  |
| 9 |  |  |  |
| 10 |  |  |  |



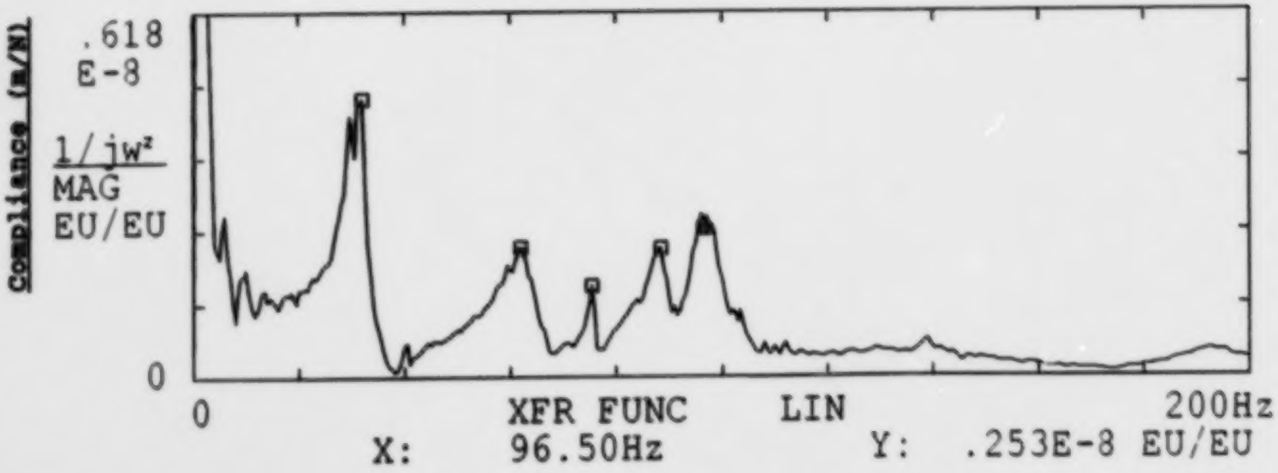
XFR FUNC LIN
X: 118.50Hz Y: .159E-8 EU/EU

00:54

## FIGURE I6

## DNGS 'A' EMERGENCY POWER GENERATOR #1 - IMPACT SPECTRUM AC GENERATOR INBOARD BEARING CASING HORIZONTAL DIRECTION

```
                XFER FUNC  MAG - PH
 1      32.00Hz       .472E-8 EU/EU    70.7 deg
 2      62.00         .221E-8         118.1
 3      75.50         .155E-8         120.9
 4      88.50         .219E-8         104.2
 5      96.50         .253E-8          81.4
 6
 7
 8
 9
10
```

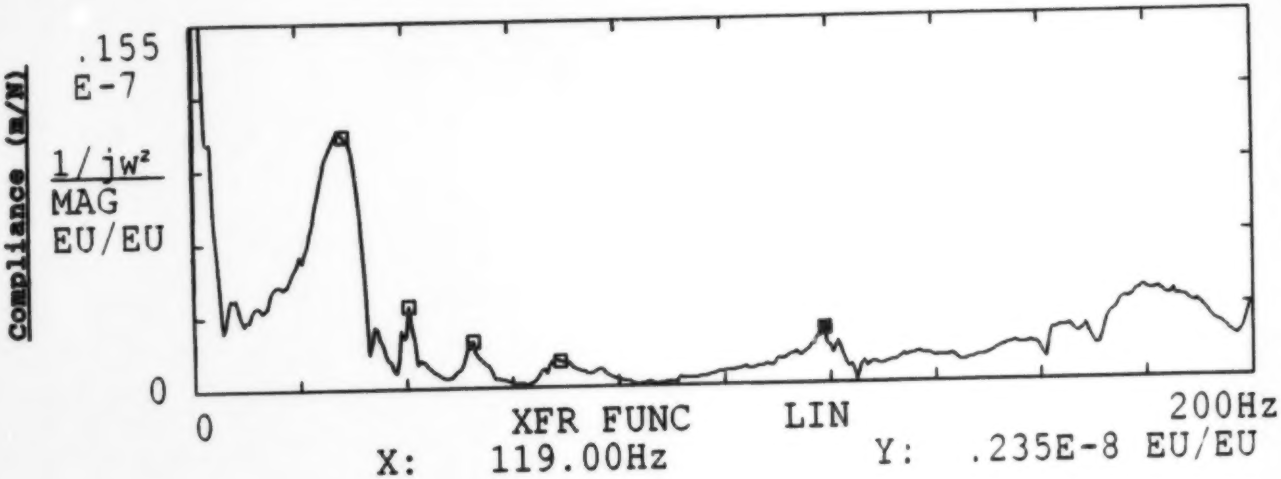


00:55

## FIGURE I7
## DNGS 'A' EMERGENCY POWER GENERATOR #1 - IMPACT SPECTRUM
## AC GENERATOR INBOARD BEARING CASING AXIAL DIRECTION

XFER FUNC  MAG - PH

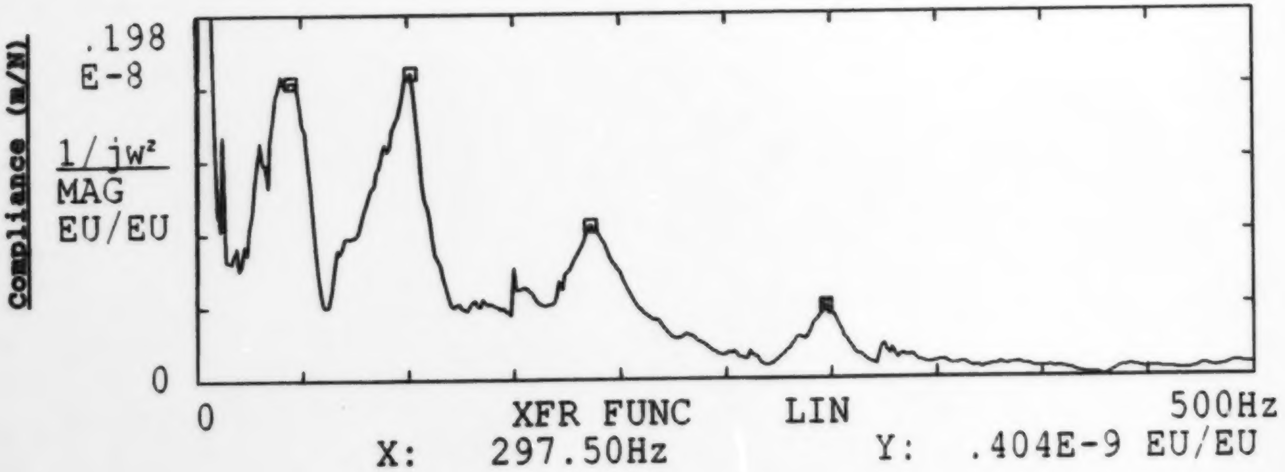
| | | | |
|---|---|---|---|
| 1 | 28.50Hz | .107E-7 EU/EU | -104.6 deg |
| 2 | 40.50 | .353E-8 | -147.1 |
| 3 | 52.50 | .203E-8 | -137.2 |
| 4 | 69.00 | .115E-8 | -100.3 |
| 5 | 119.00 | .235E-8 | -109.8 |
| 6 | | | |
| 7 | | | |
| 8 | | | |
| 9 | | | |
| 10 | | | |



00:56

# FIGURE I8
## DNGS 'A' EMERGENCY POWER GENERATOR #1 - IMPACT SPECTRUM
## REDUCTION GEARBOX VERTICAL DIRECTION

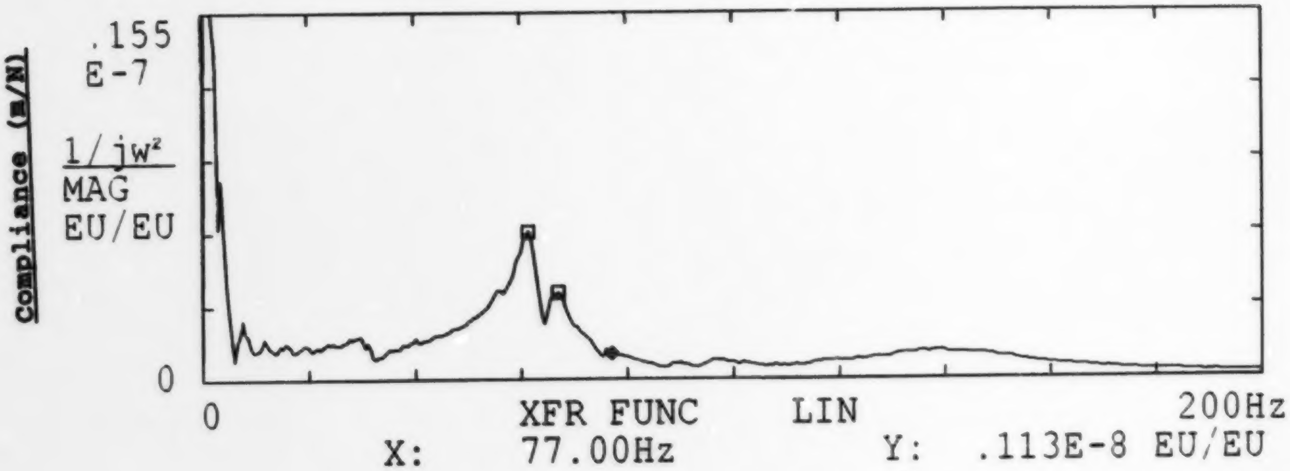
| | | XFER FUNC MAG - PH | |
|---|---|---|---|
| 1 | 45.00Hz | .162E-8 EU/EU | -55.1 deg |
| 2 | 101.25 | .168E-8 | -84.4 |
| 3 | 186.25 | .840E-9 | -108.3 |
| 4 | 297.50 | .404E-9 | -132.4 |
| 5 | | | |
| 6 | | | |
| 7 | | | |
| 8 | | | |
| 9 | | | |
| 10 | | | |



00:58

## FIGURE I9
## DNGS 'A' EMERGENCY POWER GENERATOR #1 - IMPACT SPECTRUM
## REDUCTION GEARBOX HORIZONTAL DIRECTION

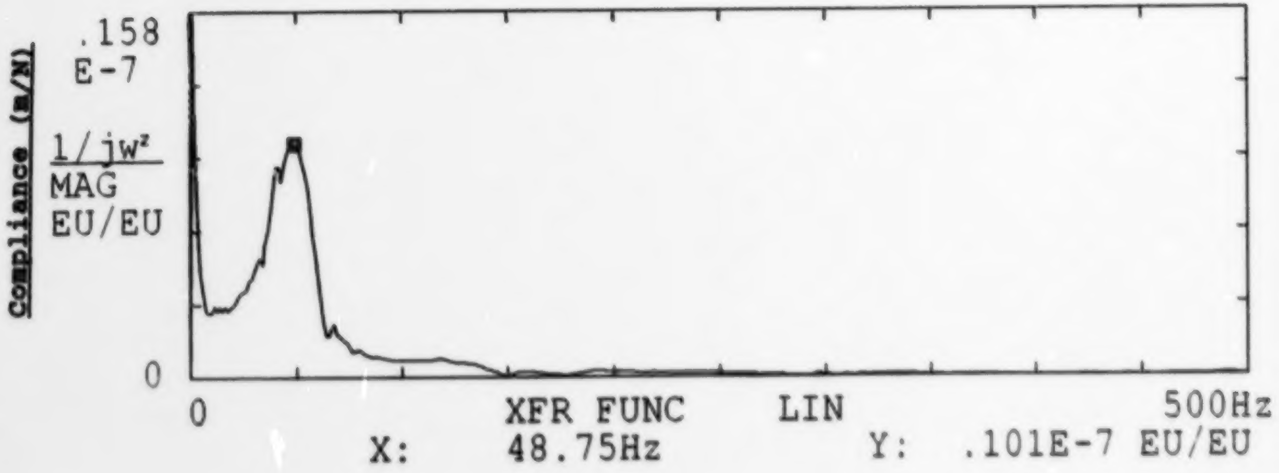
```
                XFER FUNC  MAG - PH
 1    61.50Hz       .625E-8 EU/EU   -78.0 deg
 2    67.00         .370E-8        -103.6
 3
 4
 5
 6
 7
 8
 9
10
```



01:07

## FIGURE I10
## DNGS 'A' EMERGENCY POWER GENERATOR #1 - IMPACT SPECTRUM REDUCTION GEARBOX AXIAL DIRECTION

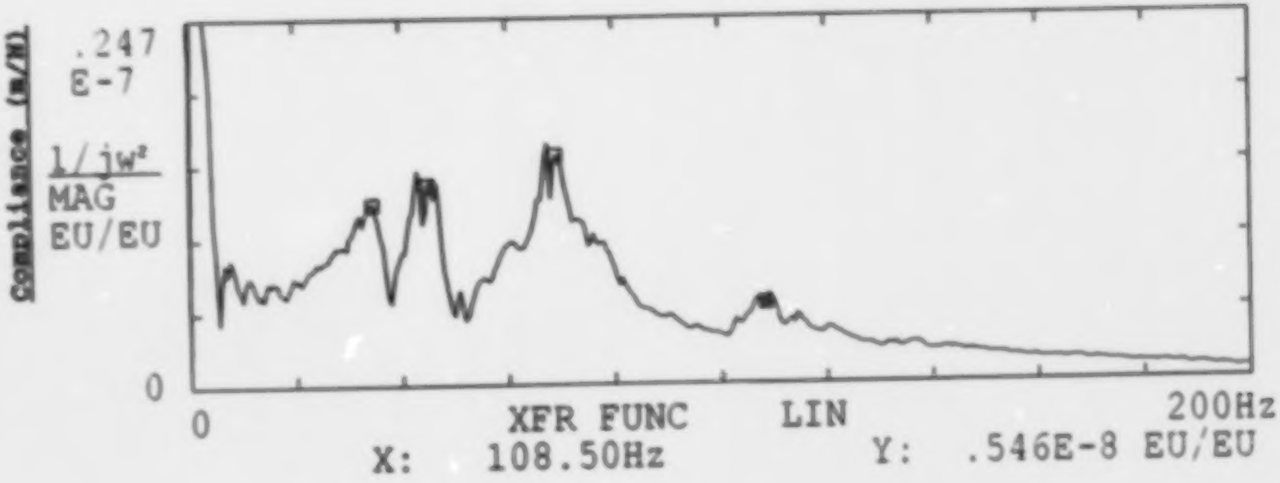
XFER FUNC MAG - PH
1 48.75Hz .101E-7 EU/EU 88.8 deg
2
3
4
5
6
7
8
9
10



01:09

## FIGURE I11
## DNGS 'A' EMERGENCY POWER GENERATOR #1 - IMPACT SPECTRUM
## POWER TURBINE BEARING NO 5 CASING VERTICAL DIRECTION

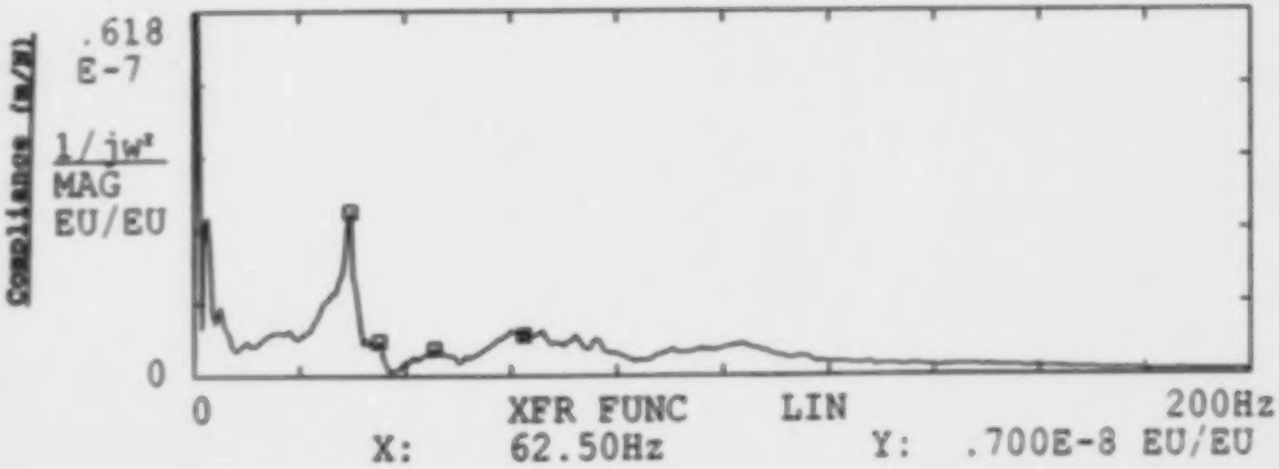
| | XFER FUNC | MAG - | PH |
|---|---|---|---|
| 1 | 34.50Hz | .123E-7 EU/EU | -43.1 deg |
| 2 | 45.00 | .136E-7 | -59.5 |
| 3 | 69.00 | .155E-7 | -100.7 |
| 4 | 108.50 | .546E-8 | -156.3 |
| 5 | | | |
| 6 | | | |
| 7 | | | |
| 8 | | | |
| 9 | | | |
| 10 | | | |



01:14

## FIGURE I12
## DNGS 'A' EMERGENCY POWER GENERATOR #1 - IMPACT SPECTRUM
## POWER TURBINE BEARING NO 5 CASING HORIZONTAL DIRECTION

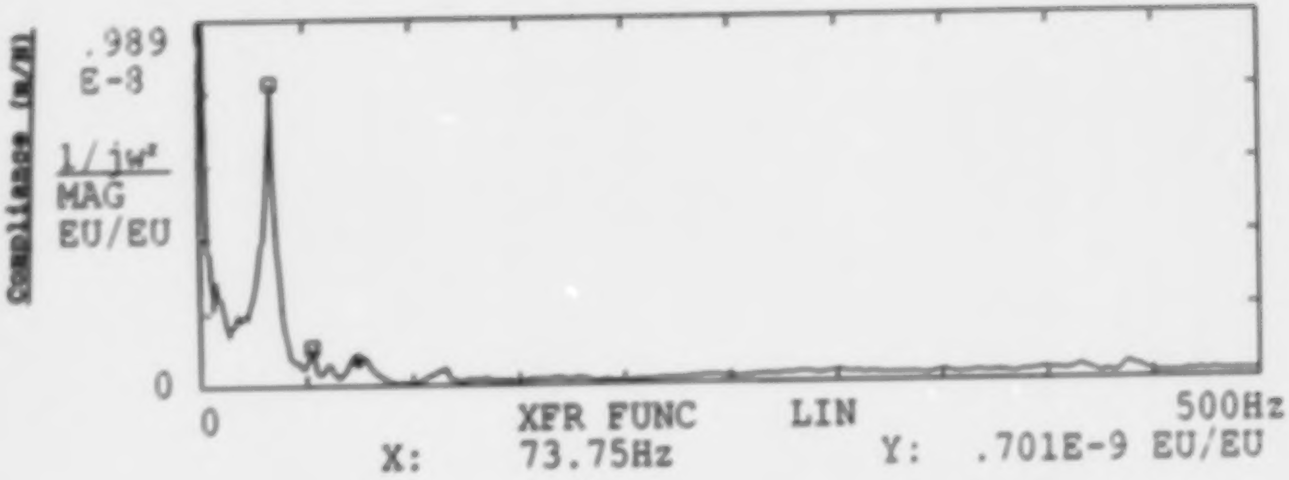
```
                    XFER FUNC  MAG - PH
 1        29.50Hz        .279E-7 EU/EU    84.1 deg
 2        35.00          .606E-8          40.9
 3        45.50          .473E-8         123.6
 4        62.50          .700E-8          95.7
 5
 6
 7
 8
 9
10
```



01:15

## FIGURE I13
## DMGS 'A' EMERGENCY POWER GENERATOR #1 - IMPACT SPECTRUM GAS PRODUCER (NEAR BEARING NO 2) CASING VERTICAL DIRECTION

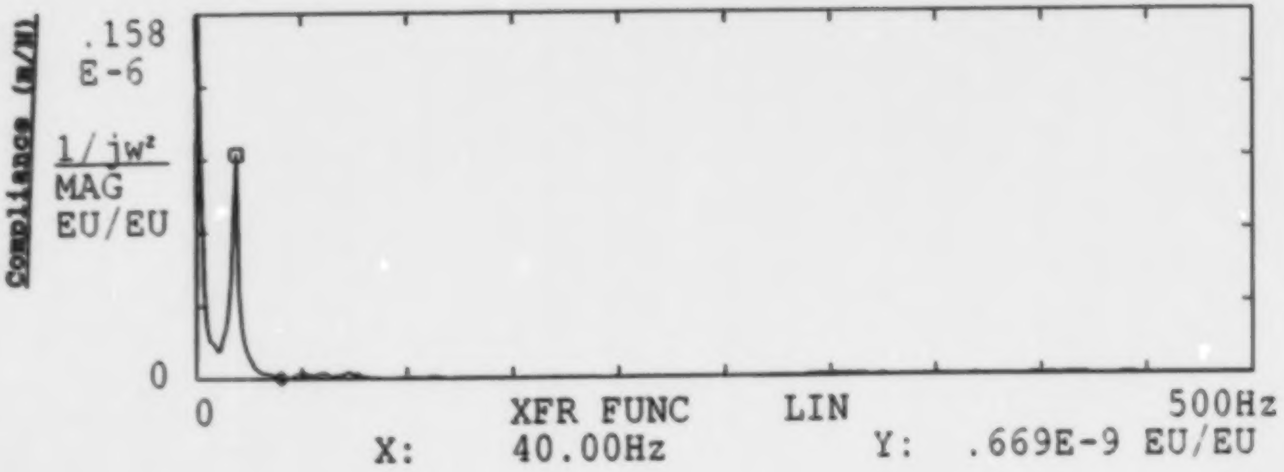
```
                XFER FUNC  MAG - PH
 1     33.75Hz        .805E-8 EU/EU    -80.1 deg
 2     52.50          .104E-8         -117.6
 3
 4
 5
 6
 7
 8
 9
10
```



01:26

FIGURE I14
DNGS 'A' EMERGENCY POWER GENERATOR #1 - IMPACT SPECTRUM
GAS PRODUCER (NEAR BEARING NO 2) CASING HORIZONTAL DIRECTION

```
           XFER FUNC  MAG - PH
 1   18.75Hz       .982E-7 EU/EU  -111.1 deg
 2
 3
 4
 5
 6
 7
 8
 9
10
```



01:28

# APPENDIX J

# INSTRUMENTATION AND MEASUREMENTS

## 1.0 INSTRUMENTATION

The main components of the instrumentation used in obtaining the various measurements are listed in Table 1 and are further discussed below.

### On-line Vibration Monitoring System

Each turbine-generator unit has an on-line vibration monitoring system which measures the overall vibration levels at selected locations. Velocity transducers are mounted in a vertical direction on the inboard and outboard bearing casings of the AC generator, on the reduction gear box (RGB) casing and on the accessory gear box casing. In addition, at each of the Bearings No 1 through No 5, two displacement transducers are mounted radially at 90 degrees to each other (horizontal and vertical directions).

### Transducers used for Vibration Acceptance Tests

The permanently installed shaft displacement transducers at Bearings No 1 through No 5 were utilized for the vibration acceptance tests. In addition, two displacement transducers were installed in the vertical and horizontal directions at each end of the AC generator close to the bearings. The sensitivity of the AC generator, power turbine and gas producer displacement transducers is 7.87 millivolts/micrometer (200 mv/mil).

The AC generator inboard and outboard bearing casing velocities, the reduction and accessory gear box casing velocities, and the power turbine casing (close to Bearing No 5) velocities were measured using accelerometers. Velocity measurements were generally obtained in the vertical, horizontal, and axial directions.

A photoelectric tachometer probe (Bruel & Kjaer MM 0024) was installed at the inboard end of the generator to provide a reference mark for phase angle and shaft speed measurements. Speed measurements on the power turbine and gas producer were obtained using the permanently installed speed transducers.

## 2.0 MEASUREMENTS

### Overall Vibration Levels

The overall casing velocity levels were determined from accelerometer signals which were integrated to velocity and then analyzed with a Bently Nevada Digital Vector Filter (DVF 3). True peak and RMS overall velocity levels were measured.

Shaft overall displacement levels were obtained by analyzing the displacement transducer signals with the DVF 3. All overall shaft displacement levels were obtained from the unfiltered (5 Hz - 1000 Hz) signals.

### Velocity and Displacement Spectra

Velocity and displacement spectra were generated from the accelerometer signals (integrated once) and displacement signals, respectively, by performing a Fast Fourier Transform (FFT) on the digitized signal.

### Bode Plots

The shaft displacement and casing velocity signals recorded during the periods of runup and rundown were analyzed using a computer managed data acquisition and analysis system developed by Mechanical Research, Ontario Hydro. Bearing housing velocity and shaft displacement magnitude and phase, at filtered 1 x shaft rotating frequency, versus shaft speed were calculated and plotted (Bode plot).

The Bode plots which show the rotor or casing response in both amplitude and phase as a function of rotor speed were used to identify rotor and structural natural frequencies.

Bode plots produced using shaft displacement transducer signals may be inaccurate if the signal from the transducer includes any appreciable amount of shaft bow or runout (ie, any deviation in the shaft surface which produces a transducer output which is not related to shaft vibration). For this reason, both uncompensated and compensated (ie, compensated for bow and runout by subtracting the slowroll vector from the displacement vector) bode plots were produced. Compensation is further discussed below.

### Impact Spectra

The AC generator, power turbine, gas producer, and reduction gear box structural natural frequencies were determined by impact testing. With the unit not running, these structures were excited throughout a range of frequencies (5-500 Hz) with a hammer having an elastomeric tip and instrumented with a force transducer. The input force (hammer) and the structure's response (accelerometer signal) signals were fed simultaneously into a dual channel FFT analyzer (Ono Sokki CF 920) which calculated the input and response spectra as well as the compliance transfer function. The validity of the transfer function was checked by the coherence of the input and response signals. The ambient noise was reduced by averaging the results of eight impacts.

All impact tests were performed when the unit was cold and not running.

## 3.0 COMPENSATION

A Bode plot will be distorted if the signal from the displacement transducer includes any appreciable amount of shaft bow or runout (any deviation in the observed shaft surface which produces a transducer output which is not related to shaft motion). Both shaft bow and runout will create an initial vector or offset in the phase and amplitude portions of the Bode plot. As the shaft speed changes, the bow or runout value (presumably a constant) vectorially combines with true shaft motion to produce the total signal sensed by the transducer. If the bow or runout is a significant portion of the total signal, the appearance of the Bode plot can be greatly altered. These alterations or distortions may include an amplitude peak and phase shift well removed from the actual critical speed, dips in amplitude rather than peaks, or no response in extreme cases.

To circumvent this problem, the displacement transducer signal at a slow shaft speed is obtained and stored. As the shaft speed changes, the slowroll displacement signal can be subtracted from the total displacement signal to yield a signal compensated for shaft bow and runout.